NEC ENERGY SOLUTIONS

ALM® 12V35 User's Guide

End User Documentation

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Comments and Questions about this Documentation

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or contact by e-mail at service@neces.com

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About this Guide

This Guide provides detailed specifications for the ALM 12V35 batteries as well as guidance on the safe and effective configuration, and operation of ALM 12V35 batteries as building blocks in various applications.

Intended Users

This ALM 12V35 User's Guide is intended for all personnel involved in designing, configuring, and installing, the ALM 12V35 batteries.

Conventions Used in this Guide

Notes, Caution, Warning, and Danger Notices

NOTE

A Notice presents information that is important, but not hazard-related.

REMARQUE

Un avis présente des informations importantes mais pas en rapport avec des situations dangereuses.

CAUTION

A CAUTION notice identifies conditions or practices that could result in minor or moderate injury, or damage to the equipment.

ATTENTION

Une MISE EN GARDE contient des informations essentielles pour éviter des dommages au système ou à l'équipement. La mise en garde peut s'appliquer au matériel ou au logiciel.

WARNING

A WARNING notice contains information essential to avoid a hazard that *can* cause severe personal injury, death, or substantial property damage if you ignore the warning.

AVERTISSEMENT

Un AVERTISSEMENT contient des informations essentielles pour éviter un danger qui peut causer des blessures corporelles graves, la mort ou des dommages matériels importants si vous ignorez l'avertissement.

DANGER

A DANGER notice contains information essential to avoid a hazard that *will* cause severe personal injury, death, or substantial property damage if you ignore the message.

DANGER

Un avis de DANGER contient des informations essentielles pour éviter un danger qui causera des blessures corporelles graves, la mort ou des dommages matériels importants si vous ignorez le message.

Introducing the ALM® 12V35

Overview

NEC Energy Solutions' ALM 12V35 product line of lithium-ion batteries (Figure 1, below and Figure 2 on page 10) are designed as a drop-in replacements for 12-volt lead-acid batteries. The ALM 12V35 batteries provide improved performance with higher power, increased safety and exceptional calendar and cycle life compared to 12-volt, lead-acid batteries. They typically serve as a standby power source in many high-availability and service-critical applications.

ALM 12V35 batteries are identical in size to common 35 Ah, 12-volt lead-acid batteries and designed to be compatible with most lead-acid chargers. This combination reduces product integration costs, minimizes OEM customer's time-to-market and aftermarket customer replacement hurdles.

Figure 1 ALM 12V35s Standard Series Battery

Figure 2 ALM 12V35i Intelligent Series Battery

ALM® 12V35 Product Line

The ALM 12V35 product line currently consists of these series of products:

- The **ALM 12V35s** is the standard series product. It can:
  - Deliver 462 watts for one (1) hour
  - Deliver 1300 watts for 20 minutes
  - Deliver up to 3000 watts in one-second pulses
  - Be fully charged (from 0 to 100%) in approximately 20 minutes
- The **ALM 12V35i HP CAN bus** and **ALM 12V35i HP SMBus** are the Intelligent and High Power series products that can deliver over 2500 watts for 10 minutes. They feature an intelligent communications interface, either the CAN bus or SMBus protocol, to external equipment. Both protocols support application-defined functions, including absolute and relative State of Charge (SOC), run-time remaining, temperatures, voltages, and more. (See Chapter 4, ALM® 12V35 Specifications, starting on page 25, for specification details.)

Each ALM 12V35 battery has integrated EverSafe™ protection and balancing circuitry (Figure 3 on page 11) that safeguard the battery from over-current, over-voltage, under-voltage, short circuit and over-temperature conditions. At the core of the ALM 12V35 are 56 A123 Systems® ANR26650*M1*B cells in a four-series, fourteen-parallel (4S14P) configuration.

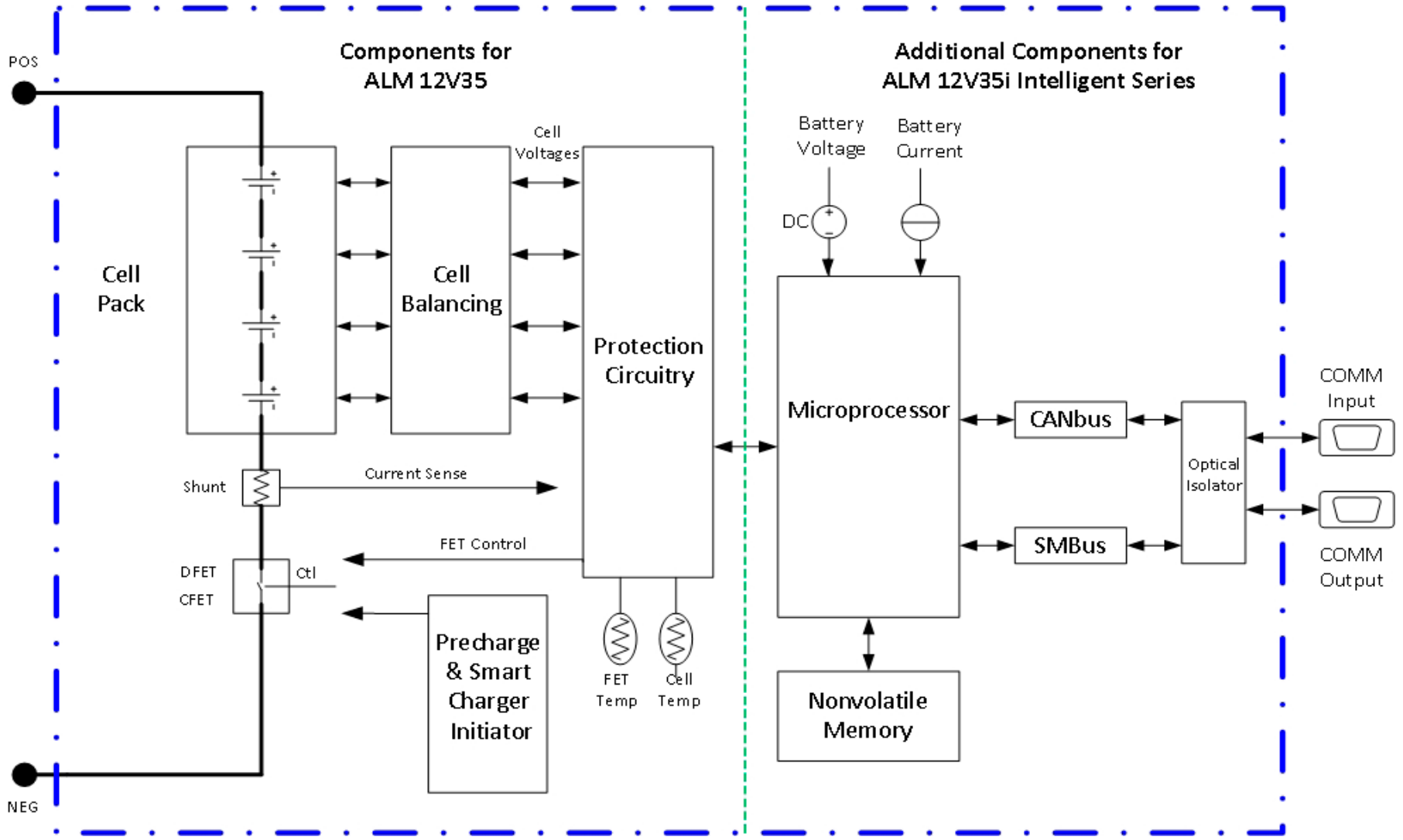


Figure 3 ALM 12V35 Battery Block Diagram

Regulatory Compliance

Overview

All ALM12V35 products are compliant with, or tested to, the following regulatory standards:

- UL 1973 Recognized – Batteries for use in Light Electric Rail (LER) Applications and Stationary Applications.
- cUL Recognized to CAN/CSA C22.2 # 60950-1 – Information Technology Equipment Safety - Part 1: General Requirements.
- IEC60529 – Meets IP54 Environmental Enclosure rating.
- IEC61000-6-1 (Generic standards – Immunity for residential, commercial and light-industrial environments).
- IEC61000-6-2 (Generic standards – Immunity for industrial environments).
- IEC61000-6-3 (Generic standards – Emission standard for residential, commercial and light-industrial environments).
- IEC61000-6-4 (Generic standards – Emission standard for industrial environments).
- IEC 62133 – Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – tested and certified.
- CE – Recognized to EU consumer safety, health and environmental regulations. Signifies conformity with EMC directive (2004/108/EC).
- FCC Part 15 Subpart B Class B – Standards regulating unintentional emissions of radio frequencies from a digital device. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
  - This device may not cause harmful interference.
  - This device must accept any interference received, including interference that may cause undesired operation.
- CISPR 22 Information technology equipment – Radio disturbance characteristics - Limits and methods of measurement
- EN55011 Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics limits and methods of measurement
- EN 55022 Information Technology Equipment – Radio Disturbance characteristics Limits and methods of measurement
- VCCI Class B ITE emissions

- ICES-003 Information Technology Equipment (ITE) – Limits and Methods of Measurement
- UN 38.3 – Meets section 38.3 of the UN Recommendations on the Transport of Dangerous Goods - Manual of Test Criteria.

Table 1 describes the ALM 12V35 product line and UL regulatory model number conventions used for third-party certification.

Table 1 ALM 12V35 Product Line UL Model Names

Regulatory Model Number	ALM 12V35 Model Names
PSL000002	12V35s
PSL000003	12V35i HP CAN bus
PSL000003	12V35i HP SMBus

Environmental Regulations

The battery is compliant with the following applicable environmental regulations.

- EU Directive 2011/65/EC on the Restriction of the use of certain Hazardous Substances (RoHS) in electrical and electronic equipment (recast)
- EU Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators
- EU Directive 1907/2006 on the Registration Evaluation Authorization and Restriction of Chemicals (REACH)
- Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation (China RoHS)

Transporting Lithium-Ion Batteries

The material presented in this guide is not all-inclusive of the regulations required to ship a product, but is meant to inform you of the complexity involved in doing so. The information contained herein is for informational purposes only and is not legal advice or a substitute for legal counsel.

Anyone involved in the integration of lithium-ion batteries into a host product must review and meet the regulations cited in this guide. Additionally, the regulations discussed in this guide apply to lithium-ion cells and batteries. Once an ALM 12V35 is integrated into a host product, the host product may be subject to additional transportation regulations that require additional certification testing. Since NEC Energy Solutions can't anticipate every possible configuration and application of the ALM 12V35, the integrator must verify that the ALM 12V35-powered host product is compliant with all applicable regulations. Refer to Table 3 on page 15 for a list of proper shipping names and UN numbers required for shipping lithium batteries.

Regulations Overview

Rechargeable lithium-ion cells and batteries are considered Dangerous Goods. The regulations that govern their transport are based on the UN Recommendations on the Transport of Dangerous Goods Model Regulations. Transport of dangerous goods is regulated internationally by:

- International Civil Aviation Organization (ICAO) Technical Instructions
- International Air Transport Association (IATA) Dangerous Goods Regulations
- International Maritime Dangerous Goods (IMDG) Code

In the United States, transportation of hazardous material (Dangerous Goods) is regulated by Title (part) 49 of the Code of Federal Regulations or CFR's. Title 49 CFR Sections 100-185 of the U.S. Hazardous Materials Regulations (HMR) contains the requirements for transporting cells and batteries. Refer to the following sections within 49 CFR for specific information.

- Section 173.185 – Shipping requirements for lithium cells and batteries
- Section 172.102 – Special Provisions
- Sections 172.101, 178 – Further information and specifications on packaging

The Office of Pipeline and Hazardous Materials Safety Administration (PHMSA), which is within the U.S. Department of Transportation (DOT), is responsible for drafting and writing the U.S. regulations that govern the transportation of hazardous materials (also known as dangerous goods) by air, ground, and ocean.

Regulations by Cell/Battery Size

Lithium-ion batteries and cells are considered Class 9, which is one of nine classes of hazardous materials or dangerous goods defined in the regulations. As a Class 9 material, cells and batteries must meet UN testing and packaging requirements as well as shipping regulations.

Following International and U.S. DOT Regulations

Failure to comply with International and U.S. DOT regulations while transporting Class 9 Hazardous Materials (Dangerous Goods) may result in substantial civil and criminal penalties.

Table 2 outlines an example process to help ensure that batteries are shipped per the required regulations.

Table 2 Example of Steps to Obtain or Ensure Regulatory Compliance

Step Number	Process Step	Comments
1	Design the battery.	Design the battery to ensure it will pass UN Manual of Tests and Criteria.
2A	Ship the battery to a UN 38.3 test house if using an outside test laboratory.	Use the "Prototype" shipping special provisions provided in the regulations.
2B	Test the battery.	Perform UN testing T1-T5, & T7 for batteries.
3	Obtain UN compliant packaging.	All Class 9 Dangerous Goods (DG) must be shipped in UN compliant packaging.[a]
4	Package the cell or battery.	Pack per regulations and per packaging manufacturer's instructions.
5	Mark and label the package.	Insure that packaging container has all the required labeling. Table 3 lists proper shipping names and descriptions for lithium-ion batteries.[a]
6	Fill out the shipping documentation.	Complete shipper's declaration for dangerous goods, airway bill, etc. [a]
7	Ship the package.	Ensure that shipping company can ship dangerous goods and that a Safety Data Sheet (or equivalent document) and any Competent Authority Approval accompanies the package. [a]

a. U.S. and international regulations require that anyone involved in the packaging, documentation, and labeling of Dangerous Goods for transportation must be trained to do so.

Table 3 shows the proper shipping names and UN numbers required for shipping lithium-ion batteries.

Table 3 Proper Shipping Names and UN Numbers

Proper Shipping Name	Description
Lithium ion batteries	UN 3480
Lithium ion batteries packed with equipment	UN 3481
Lithium ion batteries contained in equipment	UN 3481

Handling, Storage and Installation

Safety and Handling

The ALM 12V35 battery is more abuse tolerant than other lithium-ion batteries; however, correct handling and system integration of the ALM 12V35 battery are still important to ensure safe operation.

WARNING

Failure to follow these warnings may result in personal injury or damage to the equipment.

- **Do not expose the ALM 12V35 battery to heat in excess of 60 °C during operation or in storage; do not incinerate or expose to open flames.**
- **Do not connect ALM 12V35 batteries to batteries of other chemistries or ALM batteries of different capacities. For example, do not connect an ALM 12V35 to any lead-acid battery or to an ALM 12V7.**

CAUTION

Do not charge or discharge an ALM 12V35 battery outside of its stated operating temperature range. Reduce charging limits for lower operating temperatures for longer life of the batteries.

AVERTISSEMENT

Ne pas suivre ces avertissements peut entraîner des blessures ou des dommages a l'équipement.

- ***Ne pas exposer la batterie ALM 12V35 à une chaleur dépassant les 60 °C pendant son fonctionnement ou son entreposage; ne pas l'incinérer ou l'exposer à des flammes nues.***
- ***Ne pas connecter les batteries ALM 12V35 avec des batteries d'autres compositions chimiques ou avec des batteries ALM de différentes capacités. Par exemple, ne pas connecter une batterie ALM 12V35 avec une batterie d'accumulateurs au plomb ou avec une batterie ALM 12V7.***

ATTENTION

Ne pas charger ou décharger la batterie ALM 12V35 en dehors de sa plage de température fonctionnelle indiquée. Réduire les limites de chargement pour les températures fonctionnelles plus basses pour Augmenter la durée de vie des batteries.

The advanced design of the ALM 12V35 is intended to provide protection against operation under many unsafe conditions such as over-voltage, under-voltage, over-temperature and short circuit. Proper use within the limits stated in Chapter 4, ALM® 12V35 Specifications, starting on page 25, is required to ensure operator and equipment safety as well as battery life.

Mounting

ALM 12V35 batteries may be installed in any orientation.

The ALM 12V35 case, including the top cover, is capable of sustaining a mounting force of up to 25 pounds spread over a one-inch-wide bar or holding bracket across the center of the unit. Exertions beyond this level may result in deformation of the plastic.

Montage

La batterie de 12V35 ALM peut être installé dans n'importe quelle direction.

Le boîtier de la batterie 12V35 ALM, y compris le couvercle supérieur, peut soutenir une charge allant jusqu'à 25 livres répartie sur une barre d'un pouce de largeur ou sur une équerre de fixation traversant le centre de l'unité. Des efforts plus grands peuvent provoquer une déformation de la matière plastique.

Battery Configuration Options

The ALM 12V35 batteries may be arranged in series and/or in parallel configurations to achieve higher operating voltages and capacities to meet the requirements of the intended application up to a maximum of 48 volts (four in series) and 350 Ah (ten in parallel).

Wiring Connections

To connect ALM 12V35 batteries, use appropriate sized AWG wire cables and lugs that are rated for the maximum current and temperature expected. Table 12 on page 34 provides guidance on the conditions under which the battery may encounter internal thermal or external terminal touch temperature limits.

The battery can accommodate a maximum inductance of 10 µH. For reference, 10 µH is equivalent to 6 meters (20 feet) of individual standalone cable. In a battery system, cable length inductance includes all terminal-to-terminal connections as well as cabling to charge sources and load for both the positive and negative conductors added together. It is possible

to reduce a battery system's total cable inductance by orienting positive and negative conductors to cancel each other's electromagnetic induction, thus allowing for longer total cable length. Contact NEC Energy Solutions Technical Support for assistance in determining appropriate wiring and bus bar configurations to address current sharing and stray inductance requirements.

CAUTION

- **Exceeding the maximum inductance limit of 10 µH during operation could cause voltage spikes or current surges resulting in possible damage to the ALM 12V35 battery's circuitry.**
- **Do not connect the ALM 12V35 battery to an inductive load such as a DC motor without the use of a motor controller. An "on-off" switch does not constitute a motor controller. Using the batteries directly with DC motors can permanently damage the battery. Contact NEC Energy Solutions Technical Support for further assistance.**

Connexions de câblage

Pour connecter les batteries ALM 12V35, utilisez un câble AWG de la bonne taille et les tenons classifiés pour le courant et la température maximum prévus. LeTableau 13 à la page 35 fournit des directives sur les conditions dans lesquelles la batterie pourrait depasser les limites de température de contact de borne externe ou thermique interne.

La batterie peut accepter une inductance maximum de 10 µH. Comme référence, 10 µH est équivalent à 6 mètres (20 pieds) de câble autonome individuel. Dans un système de batterie, la longueur du câble inducteur comprend toutes les connexions de borne à borne, ainsi que le câblage pour recharger les sources et les charges pour les conducteurs positif et négatif combinés. Il est possible de réduire l'inductance totale de câble d'un système de batterie en orientant les conducteurs positif et négatif pour annuler mutuellement l'induction électromagnétique, permettant ainsi une plus grande longueur de câble totale. Contactez le support technique de NEC Energy Solutions pour vous aider à déterminer les configurations de câblage et de barres omnibus appropriées pour traiter le partage de courant et les exigences d'inductance parasite.

ATTENTION

- ***Le dépassement de la limite d'inductance maximale en fonctionnement de 10 µH pourrait causer des pointes de tension ou de courant et causer des dommages aux circuits de la batterie ALM 12V35.***
- ***Ne branchez pas la batterie ALM 12V35 à une charge inductive, telle qu'un moteur à courant continu, sans l'utilisation d'un dispositif de commande de moteur. Un interrupteur « marche-arrêt » ne constitue pas un dispositif de commande de moteur. L'utilisation des batteries directement avec les moteurs à courant continu peut endommager définitivement celles-ci. Contactez l'assistance technique de NEC Energy Solutions pour obtenir de l'aide.***

Terminal Specifications

ALM 12V35 batteries uses brass terminals. The terminals have a maximum operating temperature rating of 90 °C. The terminal bolt is stainless steel and of grade A4-70, has a M6 x 1.0mm thread, 16mm length, and should be torqued to 3.95 Nm (35 in-lbs) for most wire lug connections. Larger lugs or multiple cables may require a tighter connection.

When wiring lugs follow these steps:

1. Connect a wiring lug directly to the surface of each battery terminal – Do not place a washer between the terminal base and the lug.
2. Next, place a flat washer on top of the lug, followed by a split washer, and finally by the bolt head.

Refer to Table 9 on page 29, for the maximum torque specifications.

Optional Terminal Adapter

For high current connections using cable lugs requiring torque in excess of the terminal's maximum value, an optional terminal accessory kit (NEC Energy Solutions P/N 522073-001) is available to provide a larger M8 hardware connection.

Table 4 ALM 12V35 M6 to M8 Terminal Adapter Kit (P/N 522073-001)

Part Number	Description	Qty	Item Type
521999-001	TERMINAL ACCESSORY M6 TO M8, ALM12V35 (COPPER BUS BAR)	2	Part
910226-001	SCREW HEX HEAD M8 X 1.25 30MML 316 STAINLESS STEEL	2	Bolt
910227-001	NUT M8 X 1.25, 316 STAINLESS STEEL	2	Nut
910228-001	WASHER SPLIT LOCK, M8, 316 STAINLESS STEEL	2	Washer

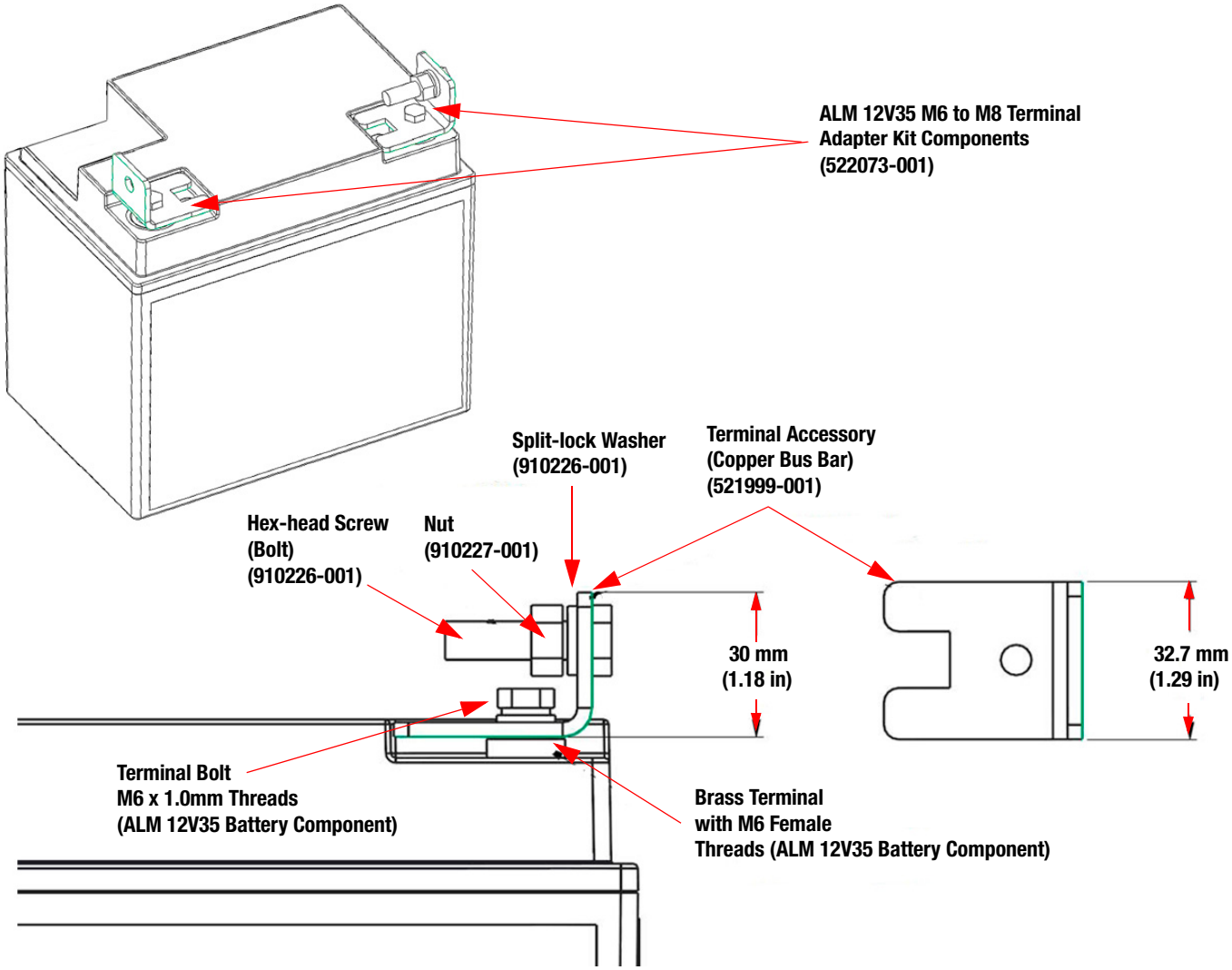


Figure 4 ALM 12V35 Terminal Accessory Kit Components

Configuring Batteries in Series Strings

To achieve higher operating voltages, arrange the batteries in series strings by connecting the positive terminal of one battery to the negative terminal of the next battery.

NOTE

The following battery string wiring examples provide general configuration information. Actual wire configurations must be evaluated for their particular application.

The array voltage can be calculated as follows:

- Two batteries in series: 2 x 13.2 V = 26.4 V (nominal) for 24 V applications
- Three batteries in series: 3 x 13.2 V = 39.6 V (nominal) for 36 V applications
- Four batteries in series: 4 x 13.2 V = 52.8 V (nominal) for 48 V applications

The maximum number of ALM 12V35 batteries that may be connected in series is four.

Figure 5 illustrates four ALM 12V35 batteries connected in a four-series, one-parallel (4S1P) configuration.

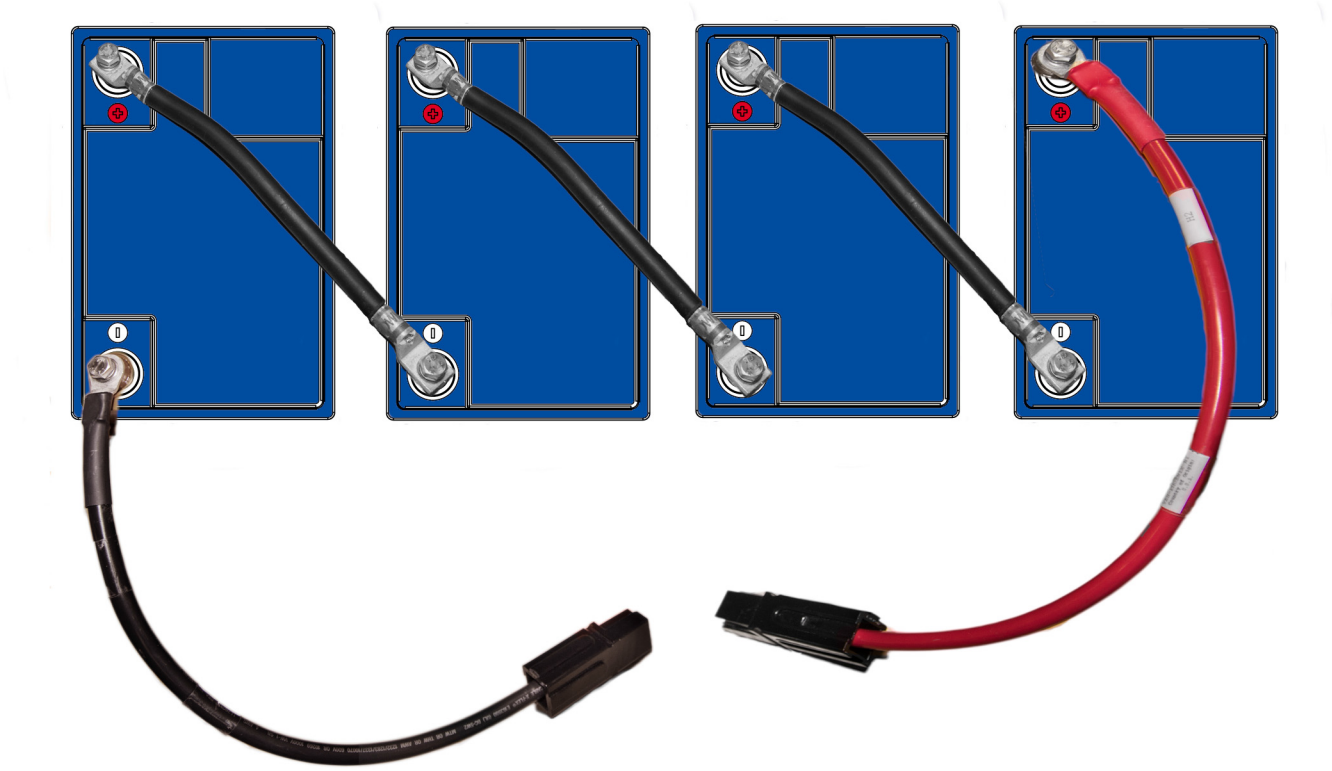


Figure 5 Four ALM12V35s Batteries Connected in Series Creating a 4S1P Configuration

Configuring Batteries in a Parallel Group (1S2P up to 4S10P)

To achieve higher capacity, arrange the batteries in a single series (1S) parallel group by connecting all like-polarity wires on adjacent batteries to an appropriately sized terminal block for your application. To ensure even loading, make two star connections; one for the positive battery terminals and one for the negative battery terminals. The cable lengths in each star group should be of approximately equal measure as permitted by the physical layout. From each star connection, use a twisted pair of cables to the load.

Reference local electrical codes and/or relevant standards for terminal block specifications. Bus bar connections are recommended for current exceeding 400 amps.

The nominal capacity for the parallel group can be calculated by multiplying the number of batteries in the group by 35 Ah. For example, three batteries in parallel provides:
3 x 35 Ah = 105 Ah.

The maximum number of ALM 12V35 batteries that may be connected in parallel is ten.

Series and Parallel Battery Configuration Warnings and Notices

WARNING

When configuring batteries in series or in parallel, adhere to the following Warning notices:

- **Do not connect more than four batteries in series. Connecting more than four batteries in series may damage the battery's circuitry, leaving the battery without critical safety features such as over-voltage and over-temperature protection.**
- **Do not connect more than ten batteries in parallel.**
- **Configuring more than one series string of batteries in parallel is allowed under certain circumstances. The maximum supported array is 4S10P. When designing and constructing any series-parallel battery combinations, contact NEC Energy Solutions Technical Support for assistance in determining appropriate wiring and bus bar configurations to address current sharing and stray inductance requirements.**
- **Consider inductance during system design. The ALM 12V35 battery can accommodate a maximum inductance of 10 µH. Exceeding this limit during operation will cause voltage or current spikes, resulting in possible damage to the battery's circuitry.**
- **Consider capacitance during system design. When a battery or battery group is connected to a heavy duty charger, external capacitance may need to be added to the circuity to address the output inductance of the charger. The CV^2 of the attached capacitor should be larger than the LI^2 of the charger. The charger inductance is the sum of the internal and external inductances.**

NOTE

The ALM 12V35 is UL Recognized as a standalone battery only and has not been evaluated by UL (or any other regulatory agency) for series and/or parallel configuration.

NEC Energy Solutions has successfully conducted noncertification testing witnessed by UL on multi-battery arrays in series/parallel configurations. It remains the end users responsibility to certify their own unique solution.

AVERTISSEMENT

Lors de la configuration des batteries en série ou parallèle, adhérer a aux regles suivantes:

- ***Ne pas connecter plus de quatre batteries en série. La connexion de plus de quatre batteries en série dépasse la limite de tension électrique de la circuiterie de protection intégrée, laissant la batterie sans fonctionnalités de sécurité cruciales comme la protection contre la surtension et la surchauffe.***
- ***Ne pas connecter plus de dix batteries ou chaînes de batteries en parallèle.***
- ***La configuration de plusieurs chaînes de batteries en parallèle est autorisée dans certaines circonstances. Le réseau maximum supporté est 4S10P. Lors de la conception et la construction de toutes les combinaisons de batteries série-parallèle, contactez NEC Energy Solutions Support Technique pour vous aider à déterminer les configurations de***

câblage et de barres omnibus appropriés pour traiter le partage de courant et les exigences d inductance parasite.

- ***Envisager l'inductance lors de la conception du système. La batterie ALM 12V35 peut supporter une inductance maximum de 10 uH. Le dépassement de cette limite en fonctionnement provoque des pointes de tension ou de courant, pouvant entraîner des dommages aux circuits de la batterie.***
- ***Envisager la capacité (Farads) lors de la conception du système. Quand un groupe de batteries ou une batterie sont connectés à un chargeur de puissance élevée, il peut être nécessaire d' ajouter à la circuiterie une capacité externe pour compenser l'inductance de sortie du chargeur. Le CV^2 du condensateur CV doit être plus grande que la LI^2 du chargeur. L'inductance de charge est la somme des inductances internes et externes.***

REMARQUE

La batterie ALM 12V35 est homologuée UL comme batterie autonome seulement et n'a pas été évaluée par l'UL (ou tout autre organisme réglementaire) pour des configurations en série et/ou parallèles.

NEC Energy Solutions a mené avec succès des tests non-accrédités vérifiés par UL sur plusieurs gammes de batteries en configuration en série et/ou parallèle. Il est de la responsabilité de l'utilisateur final de certifier leur propre solution.

Connecting ALM 12V35i Intelligent Series Communications Cables

The ALM 12V35i intelligent (i-series) battery provides two communication cables terminated with 9-pin D-sub connectors for industry standard CAN bus and SMBus communications as shown in Figure 6. Only one of the two bus interfaces is enabled depending on the ordered configuration. The connectors mate together (one male, one female) so that one battery's bus output cable can be connected to the next battery's bus input cable in any order.

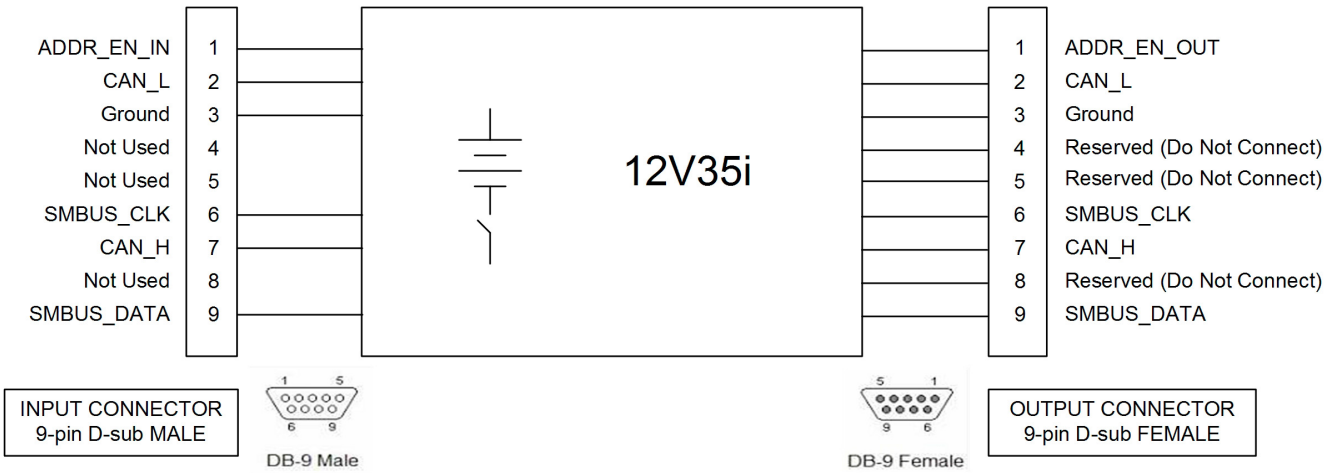


Figure 6 9-Pin D-Sub Communication Cable Connector Pin-Out Descriptions

Transportation and Storage

When storing or transporting the ALM 12V35 batteries, NEC Energy Solutions recommends the following:

- ALM 12V35 batteries can be ***stored*** in an environment with average temperatures between -40 °C and +35 °C, between 5% and 95% relative humidity, noncondensing, and at altitudes up to 25,000 feet (7600 m). Storing the ALM 12V35 in temperatures above +35 °C can significantly reduce the battery's state of charge and storage time as further described in Shelf Life on page 45.
- ALM 12V35 batteries can be ***transported*** for up to two weeks in an environment with temperatures above 35 °C up to 80 °C and at altitudes up to 50,000 feet (15,240 m).
- ALM 12V35 batteries have been tested to 11.6 kPa (50,000 feet) at 20 °C ±5 °C.

Transport et Entreposage

Lors du stockage ou du transport des batteries ALM 12V35, NEC Energy Solutions recommande la suite:

- *Les batteries ALM 12V35 peuvent être **stockées** dans un environnement avec des températures moyennes comprises entre -40 °C et 35 °C, entre 5% et 95% d'humidité relative, sans condensation, et à des altitudes jusqu'à 25,000 pieds (7600 m). Stockage de l'ALM 12V35 à des températures supérieures a 35 °C peut réduire de façon significative l'état de charge et le temps de stockage tel que décrit dans la durée de conservation à la page 46 de ce document.*
- *Les batteries ALM 12V35 peuvent être **transportées** dans n'importe quelle condition d'entreposage recommandée pendant une durée allant jusqu'à deux semaines dans un environnement où les températures dépassent les 35 °C et pouvant aller jusqu'à 80 °C.*
- *Les batteries ALM 12V35 ont été testées à 11,6 kPa (50,000 pieds) 20 °C ±5 °C.*

Operating Environment

The ALM 12V35 batteries can be operated in an environment with temperatures between -40 °C and +60 °C, between 5% and 95% relative humidity, noncondensing, at altitudes up to 15,000 feet (4572 meters). Refer toTable 6 on page 26 for environmental specifications.

Environnement d'exploitation

La batterie ALM 12V35 peut être utilisée dans un environnement avec des températures comprises entre -40 °C et +60 °C, entre 5% et 95%, d'humidité relative, sans condensation jusqu'a une altitude de 15000 pieds (4572m). Reportez vous a la Tableau 8 à la page 28, des Spécifications Environnementales.

Disposal

Do not incinerate or dispose of the battery. Return end-of-life or defective batteries to your nearest recycling center per the appropriate local regulations.

Élimination

Ne pas incinérer ou jeter la batterie. Retournez les batteries en fin de vie ou défectueuses à votre centre de recyclage le plus près en respectant les réglementations locales appropriées.

ALM® 12V35 Specifications

Electrical and Environmental Specifications

Table 5 ALM12V35 Electrical Specifications

Specification	Description
Maximum Continuous Charge and Discharge Current to 100% capacity at 25 °C [a]	105 A (ALM 12V35s) [b] 210 A (ALM 12V35i HP)[b]
Maximum Pulse Charge and Discharge Current	500 A at 0.3 sec [c] 300 A at 0.9 sec 240 A at 1.4 sec, or greater
Nominal Operational Voltage	13.2 V
Minimum Operational Voltage	8.0 V
Minimum Charge Voltage (for 10% State of Charge)	12.0 V
Maximum Charge Voltage (CC or CV)	16 volts
Recommended Float Charge Voltage	13.6 V to 14.4 V
Nominal Capacity	35 Ah
Minimum Capacity at BOL	33.6 Ah
Maximum Ripple Current at low frequencies (60Hz/120Hz)	Peaks less than ± 240 A and average less than 110 A [d]

a. Continuous current (charge or discharge) is defined as occurring over a single full-charge or full-discharge cycle.

b. Current that exceeds this value will be interrupted by the battery's protection circuitry.

c. Charge sources exceeding the continuous current will charge the battery at a duty-cycle inversely proportional to the charger's current. Exceeding 500 amps peak current will result in NO charge.

d. Although high ripple current at low frequencies (60Hz/120Hz) is not recommended, the ALM 12V35 battery will support average ripple current with peaks up to 240 amps without any adverse effects. As a comparative example, the maximum ripple current for a typical AGM (absorbent glass mat) 12 volt 35 Ah VRLA battery (@ 20hr rate) would be 35 Ah/20 hr or 1.75 amps.

Table 6 ALM 12V35 Environmental Specifications

Specification	Description
Ambient Operating Temperature Range	-40 °C to +60 °C -40 °F to +140 °F
Maximum Operating Altitude	15,000 ft [a]
Operating Relative Humidity (noncondensing)	5% to 95%
Environmental Rating for Battery Enclosure	Meets IEC60529 – IP54 Environmental Rating for Battery Enclosure
Recommended Storage Environment Conditions	Temperature: -40 °C to +35 °C [b] Relative Humidity (noncondensing): 5% to 95% Altitude: Up to 25,000 ft (7600 m)
Transportation Environment Conditions for up to two weeks [c]	Temperature: -40 °C to +80 °C Relative Humidity (noncondensing): 5% to 95% Altitude: Up to 50,000 ft (15,240 m)

a. The maximum operating temperature decreases by a factor of 1.1 °C per 1,000 ft of elevation above 7,500 ft.

b. Storing ALM 12V35 batteries in temperatures above +35 °C can significantly reduce the storage time. See Shelf Life on page 42.

c. The ALM 12V35 batteries have been tested to 11.6 kPa (50,000 ft) at 20 °C ±5 °C.

Spécifications Electriques et Environnementales

Tableau 7 Spécifications Electriques de l' ALM 12V35

Spécification	*Description*
Courant de charge et décharge continu maximum à une capacité de décharge de 100% à 25 °C [a]	*105 Ampères Puissance de base (ALM 12V35s)* [b] *210 A Haute Puissance (ALM 12V35i HP)* [b]
Courant de charge et décharge de pointe de puissance maximum (1 seconde et 10 secondes)	*500 Ampères à 0,3 sec* [c] *300 Ampères à 0,9 sec* *240 Ampères à 1,4 sec, ou plus*
Tension fonctionnelle nominale	*13,2 V*
Tension fonctionnelle minimum	*8,0 V*
Tension de charge minimum (pour état de charge de 10%)	*12,0 V*
Tension de charge maximum (CC ou TC)	*16,0 V*
Tension de charge de maintien recommandée	*13,8 V à 14,4 V*
Capacité nominale	*35,0 Ah*
Capacité minimum en début de vie	*33,6 Ah*
Courant ondulatoire maximum à faibles fréquences (60Hz/120Hz)	*Pulse Max ± 240 Ampères avec une moyenne inférieure a 110 Ampères* [d]

[a.] Courant continu est défini comme se produisant sur un cycle complet de charge ou de decharge.

[b.] Le courant qui dépasse cette valeur sera interrompu par la circuiterie de protection de la batterie.

[c.] Les sources de charge dépassant le courant continu chargeront la batterie à un régime d'utilisation proportionnel au courant de crête. Dépasser le courant de crête de 300A empêchera la charge.

[d.] Bien qu'un courant ondulatoire à faibles fréquences (60Hz/120Hz) n'est pas recommandé, la batterie ALM 12V35 prendra en charge un courant ondulatoire pouvant s'élever jusqu'à 1C (35A RMS) sans aucun effet indésirable. En guise de comparaison, le courant ondulatoire maximum pour une batterie VRLA type en fibre de verre microporeuse (AGM) de 12 volts 35 Ah serait de 35 Ah/20 heures ou de 1,75 ampères.

Tableau 8 Spécifications Environnementales de l' ALM 12V35

Spécification	*Description*
Plage de température fonctionnelle ambiante	*-40 °C à +60 °C* *-40 °F à +140 °F*
Altitude fonctionnelle maximum	*15, 000 pieds (4572m)* [a]
Humidité relative fonctionnelle (sans condensation)	*5% à 95%*
Note de l'environnement pour boîtier de batterie	*Conforme aux normes IEC60529 - IP54 environnementale pour les armoires de batteries*
Recommandées environnement de stockage conditions	*Température: -40 °C à +35 °C* [b] *Humidité relative (sans condensation): 5% à 95%* *Altitude Max: 25,000 pieds(7620 m)*
Conditions Environnementales de transport jusqu'à deux semaines. [c]	*Température: -40 °C à +80 °C* *Humidité relative (sans condensation): 5% à 95%* *Altitude Max: 50,000 pieds (15240 m)*

[a.] La température fonctionnelle maximum diminue par un facteur de 1,1 °C par 1000 pieds d'élévation au-dessus de 7500 pieds.

[b.] Stockage des batteries ALM 12V35 à des températures supérieures a 35 °C peut réduire considérablement le temps de stockage. Voir Durée de Conservation on page 46.

[c.] Les batteries ALM 12V35 ont été testées à 11,6 kPa (50,000 pieds) 20 °C ±5 °C.

Physical Specifications

Table 9 and Figure 7 on page 30 provide details of the mechanical dimensions and weight of the ALM 12V35 battery.

Table 9 ALM 12V35 Physical and Mechanical Specifications

Specification	Description
Dimensions (excluding terminals)	197 x 132 x 179.5 mm (7.8 x 5.2 x 7.1 in)
Weight (approximate)	6.3 kg (13.8 lbs)
Case Material	ABS Plastic, UL 94 5VA Flame Rating
Terminal Bolt Requirements	Stainless Grade A4-70, M6 x 1.0 mm x 16 mm, torque up to 62in-lbs (7N-m)
Maximum Terminal Temperature (before damage)	90 °C
Communications Connectors (if equipped)	9-pin D-sub

Tableau 10 et Figure 7 on page 30 fournissent des détails sur les dimensions mécaniques et le poids de la batterie ALM 12V35.

Tableau 10 ALM 12V35 Caractéristiques Physiques et Mécaniques

Spécification	*Description*
Dimensions (sans les bornes de connection)	*197 x 132 x 179,5 mm (7,8 x 5,2 x 7,1 in)*
Poids (approximatif)	*6,3 kg (13,8 lbs)*
Matériel du boîtier	*Plastique ABS, Cote d'inflammabilité conforme à UL 94 5VA*
Exigences relatives au boulon de borne	*Grade d'acier inoxydable A4-70, M6 x 1,0 mm x 16 mm, serrage au couple jusqu'à concurrence de 62 po-lb (7N-m)*
Terminal Température maximale (avant que des dommages)	*90 °C*
Connecteurs de communications (le cas échéant)	*D-sub 9 broches*

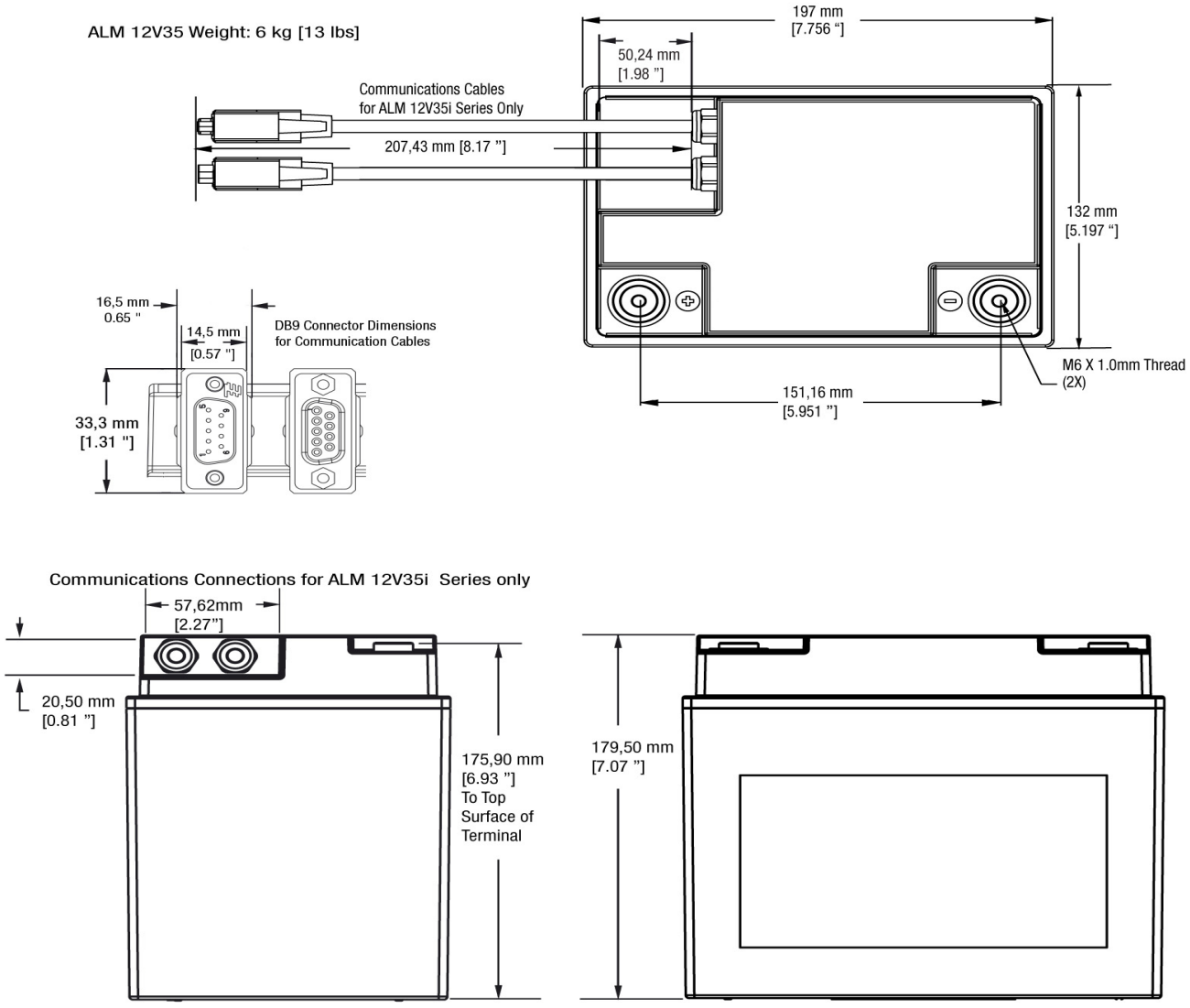


Figure 7 ALM 12V35 Mechanical Dimensions and Weight

Operation and System Design Considerations

Integrated EverSafe™ Battery Protection

The ALM 12V35 EverSafe™ battery technology includes integrated protection circuitry to prevent the battery from certain damaging use conditions. The battery's circuitry interrupts either charging or discharging current if the battery is in danger of exceeding upper or lower limits to voltage, current, and temperature.

Transient Energy Limit

The battery is designed to protect itself from transients which contain excess energy of up to 2.5 Joules. Inductance inherent in the cabling used to connect to the battery can store this transient energy and release it to the battery's protection devices as the battery's protection mechanism engages which introduces an open circuit. When that occurs, active sources like power supplies and battery chargers can create large transient spikes. While the product has been designed to handle a maximum inductance of 10 µH and tolerate connections to most power supplies, the user is responsible for ensuring that the battery does not experience over voltage surge energy in excess of 2.5 Joules when conduction is interrupted. External energy absorption devices like capacitors or clamps can reduce the overshoot or stress on the battery and may be required based on the application.

Over Current Protection

The ALM 12V35 battery applies a time-based current limit profile that allows higher level current pulses for short durations. Figure 8 on page 32 shows the maximum amplitude limits enforced over increasing time intervals. This curve has a -2% / +15% tolerance. The maximum amplitude limit of 500 amps decreases over time until it reaches a steady state limit of 240 amps at 1.4 seconds. This profile applies to both charge and discharge operations.

Figure 8 provides more detail on the current limit curve being enforced.

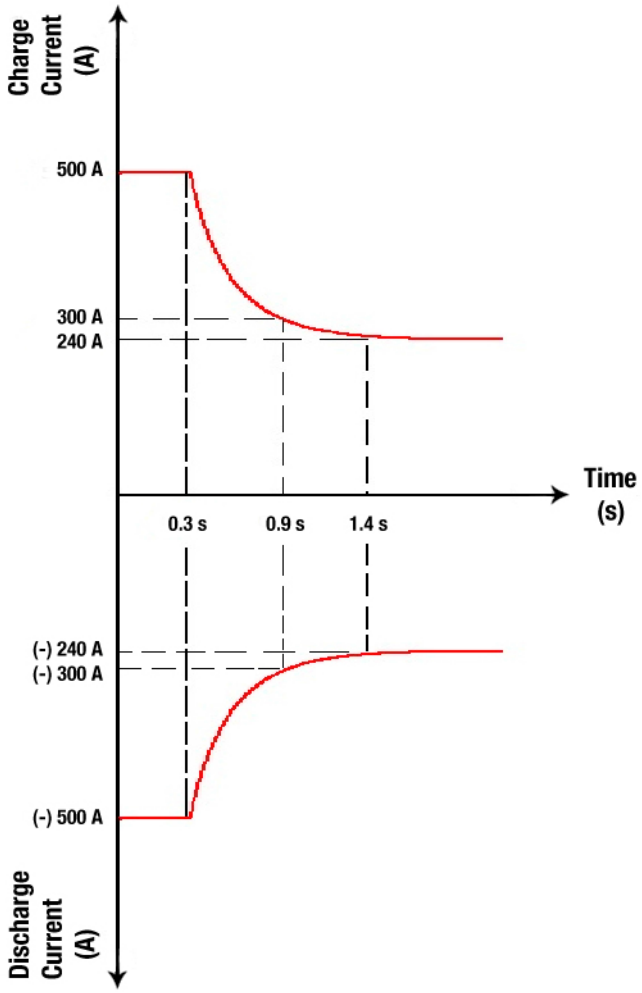


Figure 8 ALM 12V35 Current Limit Profile

Over Discharge Protection (Under Voltage Protection)

As the battery nears 0% State of Charge (SOC), the terminal voltage begins to drop rapidly. The ALM 12V35 is considered fully discharged when any one of its internal cell voltages falls to 2.0 volts or the battery's terminal voltage is in the range of 8.0 volts to 11 volts.

The ALM 12V35s is designed to enter an Under Voltage Protection (UVP) state if any cell drops below 2 volts. The ALM 12V35i is designed to enter the UVP state if any cell drops below 2.2 volts. In the UVP state, the ALM 12V35 will disconnect its terminals causing the output voltage to drop to 0 volts. Slight differences in the cells' state of charges lead to differences between the cell voltages, especially at low states of charge. In such a case, one cell may trip the UVP protection before the others do. When this happens the voltage measured at the battery terminals will be higher than 8 volts. Table 11 on page 33 shows the voltage at which an ALM 12V35s could enter UVP and open the terminals. UVP is disabled and the terminals are closed once the ALM 12V35s is connected to an active charge source and/or the lowest cell voltage returns to 2.5 volts for the ALM 12V35s (2.7 volts for the ALM 12V35i) or higher.

Table 11 End of Discharge – Effective ALM 12V35 Terminal Cut-Off Voltages in Different Series Configurations

ALM Configuration	Typical Observed ALM Terminal Cut-Off Voltage (V)	Average Voltage per Cell (V)	Absolute Minimum ALM Terminal Cut-Off Voltage (V)
1S - (12 V)	9.8	2.45	8.00
2S - (24 V)	20.3	2.54	16.00
3S - (36 V)	30.7	2.56	24.00
4S - (48 V)	41.1	2.57	32.00

NOTE

Under voltage protection creates an open circuit, removing voltage from the terminals. With a lead-acid battery, finding no voltage at the terminals often indicates the battery is no longer usable. With the ALM 12V35 battery, no voltage at the terminals typically means the cell protection circuitry has interrupted current to protect the battery. Simply connect the battery to a charge source to restore voltage to the terminals.

Smart Charger Support

Smart charger technologies require the presence of a terminal voltage before supplying a charge current. To support smart chargers when in a protection state (i.e. Under Voltage Protection (UVP) the ALM 12V35 will present a current limited terminal voltage. When there is no charger or load connected, there is no current flowing so the circuit allows the terminals to show the actual battery voltage. This terminal voltage can be measured with a multi-meter or other high impedance voltage measurement device.

Over Charge Protection (Over Voltage Protection)

Similar, but opposite to the case at low states of charge, the ALM 12V35's terminal voltage begins to rise rapidly at high states of charge. The ALM 12V35 is considered at 100% SOC when the cells are balanced and terminal voltage measures 13.8 volts or above. At this point, the average cell voltage is the terminal voltage divided by 4. The ALM 12V35 is designed to enter an Over Voltage Protection (OVP) state if any cell rises above 4.1 volts. In the OVP state, the ALM 12V35 will disconnect its terminals and not accept further charge current. To exit the OVP state, apply a load to discharge the ALM 12V35. The battery's internal balancing circuitry will also cause an automatic exit of this state, but it may take longer. The ALM 12V35 will return to Normal State once the cell voltages fall below 4.0 volts. For further details, refer to Balancing, on page 44.

Over Temperature Protection

The ALM 12V35 battery's circuitry continuously monitors the battery's temperature. The battery will open its terminals before the temperature is too high for safe operation. Do not operate the battery outside of the operational temperature range specified in Table 6 on page 26.

High Temperature Operation

Both charge and discharge functions increase battery temperatures. High rate battery usage causes the largest temperature increase. The ALM 12V35 battery's over temperature protection (OTP) circuitry disconnects the terminals if the battery exceeds the temperature limits. During high rate battery usage, the user must ensure that ambient operating temperature combined with the charge or discharge rate does not exceed the operational temperature limits. Table 12 shows how the ALM 12V35 usage rate and ambient temperature relate to measured delta SOC before entering OTP state.

Under certain conditions, the ALM 12V35 terminals will exceed the 70 °C touch temperature limit as described in UL 1973. For operation beyond those touch temperature limits, not to exceed 90 °C, the ALM 12V35 will require the placement of guards to prevent accidental contact. NEC Energy Solutions recommends that additional testing be conducted under specific use cases. The gauge of wire may be changed depending on final temperature requirements and application.

Table 12 Thermal Capability and Delta SOC, BOL [a]

Usage Rate: Charge or Discharge Current (A)	25 °C Ambient [b c]		60 °C Ambient [b c]	
	ALM 12V35s	ALM 12V35i HP	ALM 12V35s	ALM 12V35i HP
	% delta SOC	% delta SOC	% delta SOC Internal Limit	% delta SOC Internal Limit
35	100	100	100	100
70	100	100	97 (63 TT[d])	96
105	100	100	54 (36 TT[d])	74 (46 TT[d])
140	80	100	36 (24 TT[d])	61 (31 TT[d])
175	59	100	28 (17 TT[d])	49 (22 TT[d])
210	47	100	23 (14 TT[d])	44 (17 TT[d])

a. The values in this table show the battery's performance prior to engaging its protection circuitry.
b. Testing with 1/0 cables (25 °C) and 4/0 cables (60 °C)
c. 100% = 35 Ah
d. TT = Touch Temperature. The % delta SOC TT when Touch Temperature (TT) of the terminal exceeds 70 °C. A cover or other protection is required to prevent incidental contact per UL1973.


NOTE

Cell life will be limited by exposure to high temperatures.

Fonctionnement à haute température

Les deux fonctions de charge et de décharge augmentent températures de batterie. Utilisation élevée de la batterie de taux provoque la plus forte augmentation de température. La batterie ALM 12V35 «plus de la protection de température (OTP) circuit supprime la tension des bornes si la batterie dépasse les limites de température. Lors de l'utilisation de la batterie de taux élevé, l'utilisateur doit se assurer que la température ambiante de fonctionnement combiné avec la charge ou de décharge taux ne dépasse pas les limites de températures de fonctionnement. Tableau 13 montre comment le taux d'utilisation ALM 12V35 et la température ambiante concernent mesurée SOC delta avant d'entrer dans l'état OTP.

Sous certaines conditions, les bornes de connection de l' ALM 12V35 dépasseront la limite de température de contact de 70 °C, ne pas dépasser 90 °C, comme décrit dans UL 1973. Pour un fonctionnement au-delà des limites de température de contact, l' ALM 12V35 nécessitera la mise en place de protections pour empêcher tout contact accidentel. NEC Energy Solutions recommande que des tests supplémentaires soient effectues pour chaque cas d'utilisation spécifiques. La jauge de fil peut être modifiée en fonction des exigences du température finale et application.

Tableau 13 Capacité Thermique et Delta État de Charge, Début de la Vie[a]

Taux d'utilisation Charge/ Décharge Courants (A)	Température ambiante de 25 °C [b c]		Température ambiante de 60 °C [b c]	
	ALM 12V35s	ALM 12V35i HP	ALM 12V35s	ALM 12V35i HP
	% delta SOC	% delta SOC	% delta SOC Limite interne	% delta SOC Limite interne
35	100	100	100	100
70	100	100	97 (63 TC [d])	96
105	100	100	54 (36 TC [d])	74 (46 TC [d])
140	80	100	36 (24 TC [d])	61 (31 TC [d])
175	59	100	28 (17 TC [d])	49 (22 TC [d])
210	47	100	23 (14 TC [d])	44 (17 TC [d])

a. Les valeurs indiquées dans ce tableau montrent les performances de la batterie avant que les circuit de protection ne soient actifs.

b. Essai avec câbles 1/0 (25 °C) et 4/0 (60 °C)

c. 100% = 35Ah

d. TC = Température de contact dépasse. Le SOC TC % delta lorsque TC du terminal de la batterie dépasse 70 °C. Une protection de couverture ou autre est nécessaire pour empêcher un contact accidentel à la borne, conformément à la UL1973 réglementation.

REMARQUE

La durée de vie les éléments de la pile seront limites par l'exposition à des températures élevées.

Low Temperature Operation

At low temperatures, the maximum available discharge power decreases due to increased internal impedance at lower temperatures. Refer to Figure 12 on page 43 for more details.

NOTE

Do not operate the battery outside of the operational temperature range specified in Table 6 on page 26.

REMARQUE

Ne pas faire fonctionner la batterie en dehors de la plage de température d'exploitation précisée dans Tableau 8 à la page 28.

Charging Single Batteries

The ALM 12V35 is compatible with most common 12-volt, lead-acid battery chargers. A single ALM 12V35s can accept continuous charge current up to 105 amps (210 amps for the ALM 12V35i HP) maximum. Higher current for short durations is allowed. However, in some situations, internal component temperatures may be exceeded causing performance to be curtailed by the battery's protection circuitry. For more information on hardware protection limits, refer to Appendix A, ALM® 12V35 Operational Protection Alarms and Settings on page 56.

NOTE

Use of chargers with a temperature compensation feature, typically required for lead-acid batteries, may result in an incomplete or possibly no charge at elevated temperatures, but will not damage the battery. It is recommended that such temperature compensation features be disabled.

Constant Current (CC), Float Voltage Chargers

For ALM 12V35 batteries operating under normal conditions during a charge, a charger applies Constant Current (CC) until the terminal voltage reaches its End of Charge (EOC) voltage (maximum), as shown Figure 9 on page 37. This process is followed by a float voltage, where the charge current decays to near zero. As the battery approaches 100% SOC, the balancing circuitry performs cell balancing. This process charges the ALM 12V35 battery to 100% SOC.

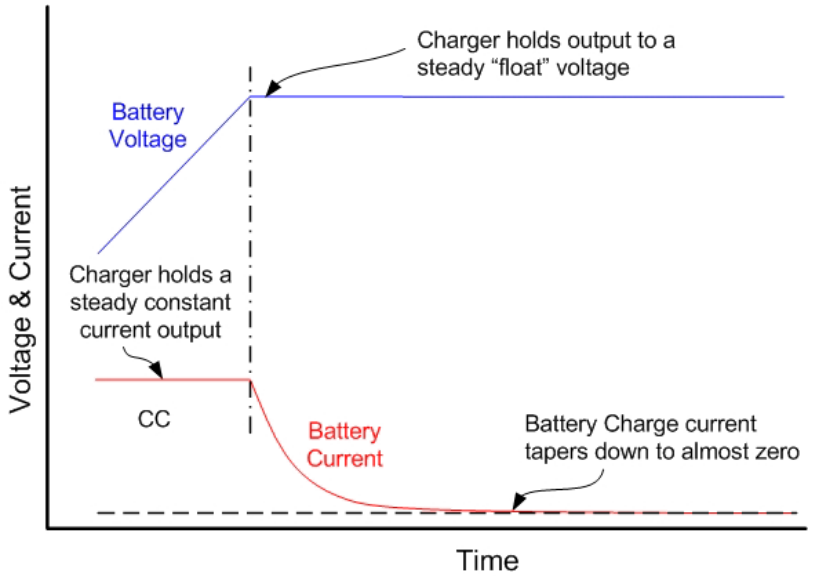


Figure 9 Battery Voltage and Current During Normal Charge

If the ALM 12V35 has entered an UVP state, the battery disconnects from the load. Connecting a charger to the battery resumes normal operation based on replenished energy.

NOTE

New batteries may be used as received. However, to ensure that all cells are balanced and fully charged before their first use, individual batteries should be charged for 4 to 24 hours with a float charge. Charging is particularly necessary prior to performing capacity tests. After initially balancing the batteries, normal use should maintain the cells in a proper state.

REMARQUE

Les nouvelles batteries peuvent être utilisees tels que reçu. Cependant, our s'assurer que tous les elements de la pile sont équilibrés et pleinement chargés avant leur première utilisation, les batteries individuelles devraient être chargées pendant 4 à 24 heures avec une charge de maintien. La charge est particulièrement nécessaire avant de procéder à des tests de capacité. Après équilibrage d'abord les piles, l'utilisation normale devrait maintenir des elements de la pile en bon état.

Charge Limits and Temperatures

At room temperature and above, the ALM 12V35 battery can accept full rated charge. As with all battery technologies, charge acceptance is limited at low temperatures. A permanent loss of capacity may be observed if charge rates are not reduced at low cell temperatures. As the cells' temperature rises during the charging process, they can gradually accept higher currents. The ALM 12V35 batteries can be charged without capacity loss at rates shown in Table 14 on page 38.

Table 14 Charge Rate by Temperature[a]

Temperature (°C)	Current (A)	Temperature (°C)	Current (A)
60	210	10	35
50	210	0	17.5
40	210	-10	10.5
30	210	-20	7
25	210	-30	1.75
20	105	-40	0.5

a. For charge acceptance, do not exceed the limits specified. For the higher temperatures (and charging rates), exceeding these rates may result in engaging the ALM 12V35's protection circuitry. For lower temperatures, exceeding these rates will result in a shorter battery life.

Chargez Limites et températures

A température ambiante et au-dessus, les batteries ALM 12V35 peuvent accepter la pleine charge nominale. Comme avec toutes les technologies batteries, de l'acceptation de charge est limitée à basse température. Une perte permanente de capacité peut être observé si les taux de charge ne sont pas réduits à basses températures des elements de la pile. Comme la température des elements de la pile augmente pendant le processus de charge, ils peuvent accepter progressivement des courants plus élevés. Les batteries ALM 12V35 peuvent être chargees sans perte de capacité aux taux indiqués dans le Tableau 15.

Tableau 15 Taux des frais par Température [a]

Température (°C)	*Courants (A)*	*Température (°C)*	*Courants (A)*
60	*210*	*10*	*35*
50	*210*	*0*	*17,5*
40	*210*	*-10*	*10,5*
30	*210*	*-20*	*7*
25	*210*	*-30*	*1,75*
20	*105*	*-40*	*0,5*

a. Pour acceptation de charge, ne pas dépasser les limites spécifiées. Pour les températures plus élevées (et les taux de charge), le dépassement de ces taux peut entraîner engager le circuit de protection de l' ALM 12V35. Pour des températures plus basses, le dépassement de ces taux entraînera dans une vie courte de la batterie.

Charging Multiple Batteries

When charging multiple batteries, maximum charge current should not exceed 210 amps for arrays of ALM 12V35 batteries connected in parallel and/or series configurations. The end-of-charge voltage and maximum allowed and recommended currents will depend on the system's series and parallel configuration.

Charging Batteries in Series

To determine the maximum end-of-charge voltage to apply for battery systems configured in series, multiply the number of batteries connected in series by the maximum charge voltage of a single battery (14.4 V), as shown in Equation 1.

Eq. 1 (Number of ALM 12V35 batteries Connected in Series) x (14.4V) = Max Charge Voltage, Battery System.

Table 16 shows Recommended Float and Maximum Charge voltages. Charger voltages exceeding the Maximum up to 60.0 volts will not damage the ALM 12V35, but the ALM 12V35 may not operate due to over voltage protection. When the battery is in the normal state, the charger voltage should be less than or equal to the Maximum Charge Voltage.

WARNING

Applying charger voltages in excess of 60.0 volts could damage the charge and discharge control circuitry, creating a safety hazard, and will void the warranty.

Table 16 Supported Float and Maximum Charge Voltages

Series Configuration	Recommended Float Charge Voltage (V)	Maximum Charge Voltage (V)
1s	13.6 to 14.4	16
2s	27.2 to 28.8	32
3s	40.8 to 43.2	48
4s	54.4 to 57.6	60

Charging Batteries in Parallel

The maximum charge current for any parallel array of batteries is 210 amps.

Chargement des Piles dans la Série

Pour déterminer la tension maximale en fin de charge à appliquer pour les systèmes de batterie configurés en série, multiplier le nombre de batteries connectées en série par la tension de charge maximale d'une seule batterie (14,4 V), comme indiqué dans l'Equation 2.

Eq. 2 (Nombre de batteries ALM 12V35 connectées en série) x (14,4V) = Tension de charge maximale, système de batterie x (14.4V) = Tension Max Charge, Système de batterie.

Le Tableau 17 à la page 40 montre la tension de maintien recommandée et tensions charge maximale. la batterie ne sera pas endommagée par des tensions de charge ne dépassant pas 60V, mais l' ALM 12V35 peut ne pas fonctionner en raison de protection contre les surtensions. En condition normale, la, tension de charge doit être inférieure ou égale à la tension de charge maximale.

AVERTISSEMENT

Appliquer des tensions de charge excédant 60.0 volts pourrait endommager la circuiterie de commande de charge et de décharge, créant un risque d'accident, et annulera la garantie.

Tableau 17 Tension de maintien et les tensions charge maximale

Configuration de Série	*Tension de Maintien Recommandée Tension de charge (V)*	*Tension de charge maxima le (V)*
1s	*13.6 to 14.4*	*16*
2s	*27.2 to 28.8*	*32*
3s	*40.8 to 43.2*	*48*
4s	*54.4 to 57.6*	*60*

Recharger les batteries en parallèle

Le courant de charge maximum pour un réseau parallèle de batteries est de 210 Ampères.

Discharge Performance

The typical 25 °C constant current discharge behavior of the ALM 12V35 at different discharge rates is shown in Figure 10. Compared to lead-acid batteries, the output voltage of the ALM 12V35 remains relatively constant across its capacity range at any given discharge rate.

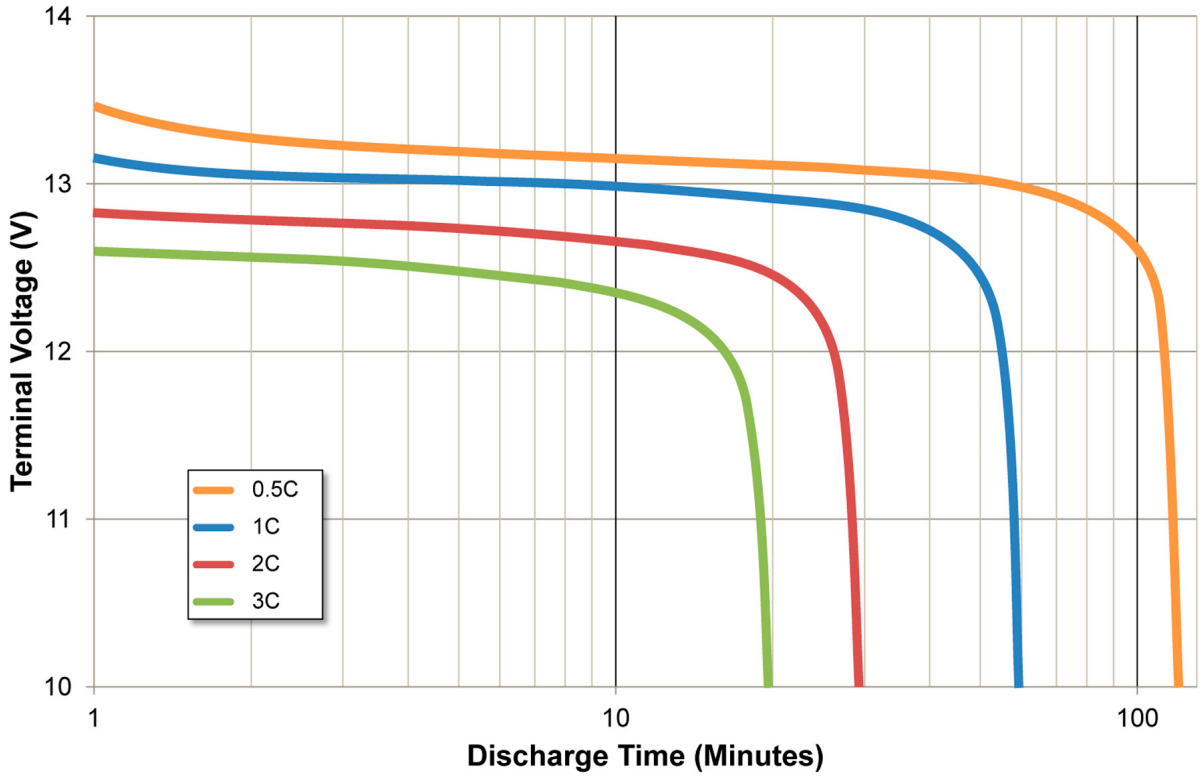
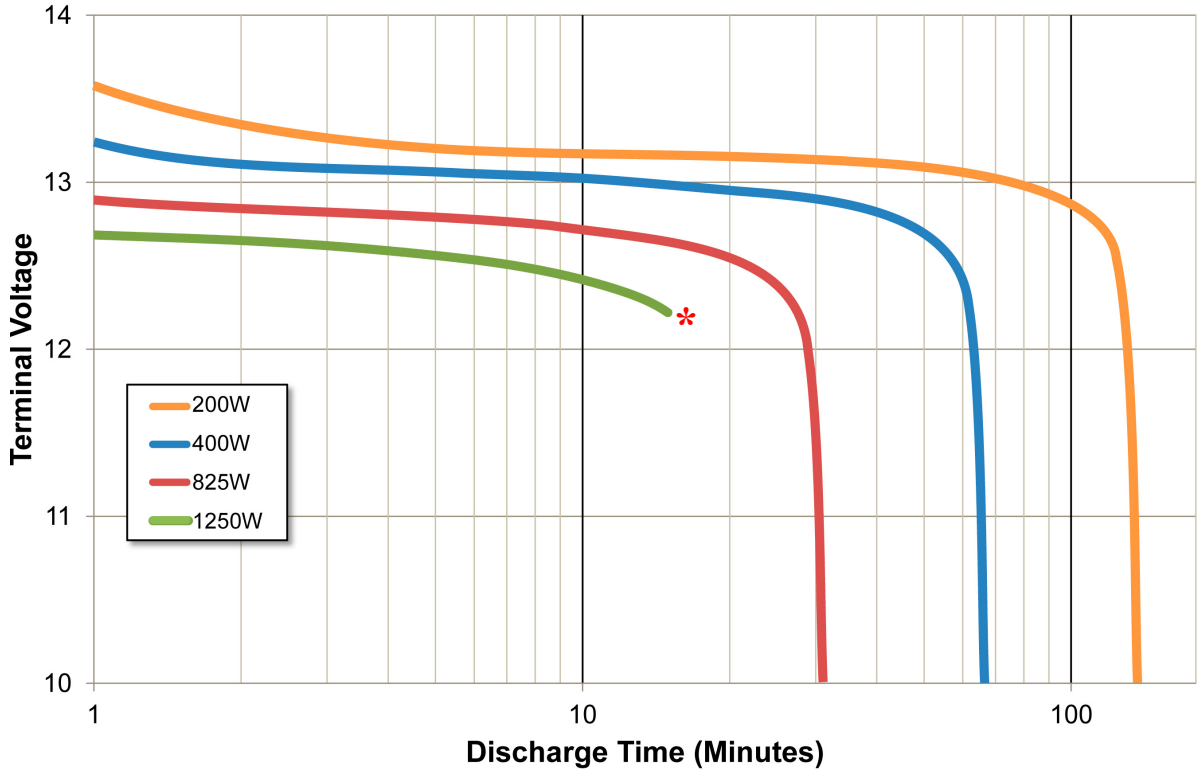


Figure 10 ALM 12V35 Typical Constant Current Discharge Behavior at 25 °C

As the ALM 12V35 discharges, limited voltage drop translates into superior (I x V) power delivery capability as shown in Figure 11. Additionally, ALM 12V35 delivered capacity is nearly independent of discharge rate.



***Note: At this power level, the maximum discharge current is 105 A. Refer to Table 5 on page 25, for discharge limits.**

****Remarque: A ce niveau de puissance, le courant maximal de décharge est de 105 A. Reportez-vous à Tableau 7 à la page 27, pour les limites de déchargé.***

Figure 11 ALM 12V35 Typical Constant Power Discharge Behavior at 25 °C

Voltage drop in the ALM 12V35 is an inverse function of the ALM 12V35's internal temperature. As the internal temperature of the ALM 12V35 drops, the impedance rises leading to an increased voltage drop. It is important to consider the resulting performance impacts when designing a product for cold conditions. Figure 12 shows impacts of temperature on 400 W constant power discharge.

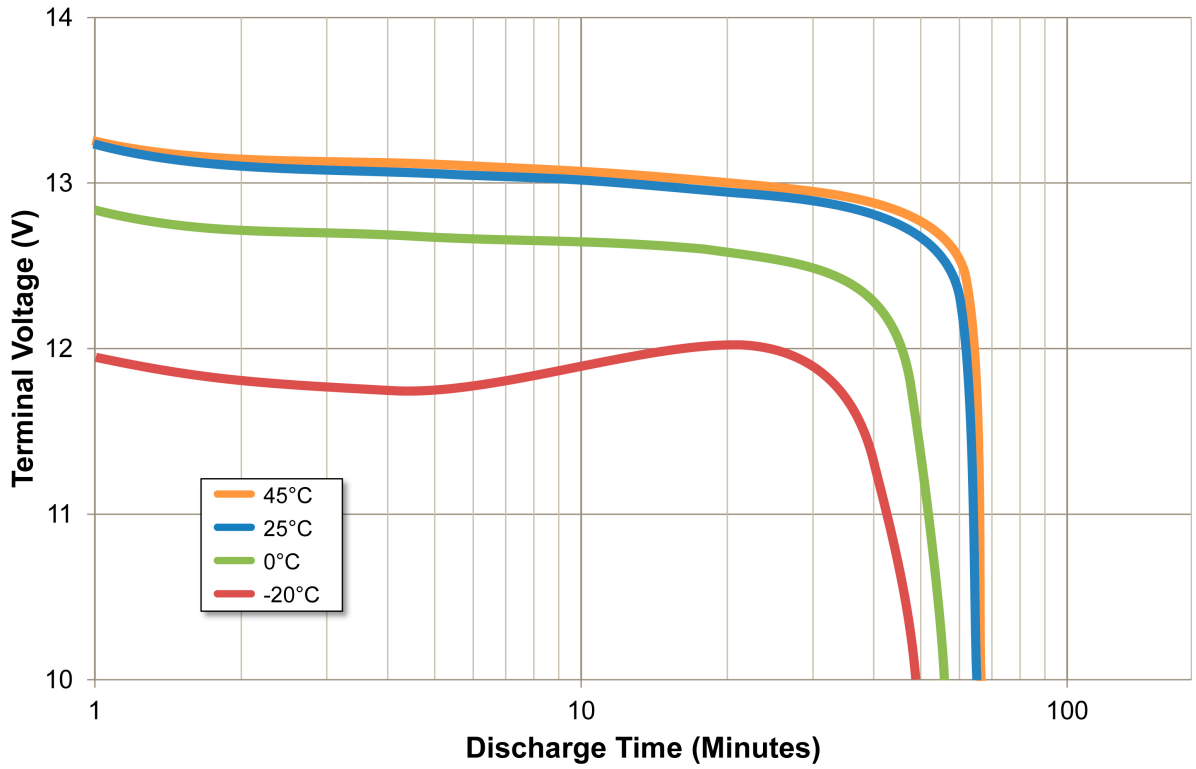


Figure 12 ALM 12V35 Typical 400 W Constant Power Discharge Behavior

The ALM 12V35 battery End of Discharge (EOD) terminal voltage is a function of the core cells, any cell-to-cell variations and series impedance of the internal power pathway. These elements are impacted by discharge rate and temperature. The battery's protection circuitry will stop discharge when any cell voltage drops below 2.0 volts.

Cell-to-cell variation has the largest impact on the expected EOD terminal voltage. Cells vary in performance in a variety of ways based on normal manufacturing.

Applications that use a low battery voltage threshold value (LVCO, LVLD, LVBD, etc.) to initiate actions such as disconnecting the load or initiating a charge cycle should adhere to the battery terminal voltages shown in the discharge performance curves in Figure 10, Figure 11, and Figure 12. Depending on the discharge rate, temperature, and other factors in the application, a different voltage trigger value based on the appropriate discharge curve may be needed compared to lead-acid or other battery chemistries. Otherwise, undesired behavior of the battery application may occur such as the unexpected loss of voltage if the ALM 12V35 enters UVP state, or taking action too soon such as disconnecting the load while significant energy still remains in the battery.

If the intent of the application is to maximize the amount of energy available from the ALM 12V35 battery before charging, it may be advantageous to disable external cutoff mechanisms based on the terminal voltage and instead use the battery's internal protection circuitry to determine when to interrupt the discharge cycle. The battery protects itself from unsafe conditions and typically disconnects due to low voltage when only 5-10% of full charge capacity remains.

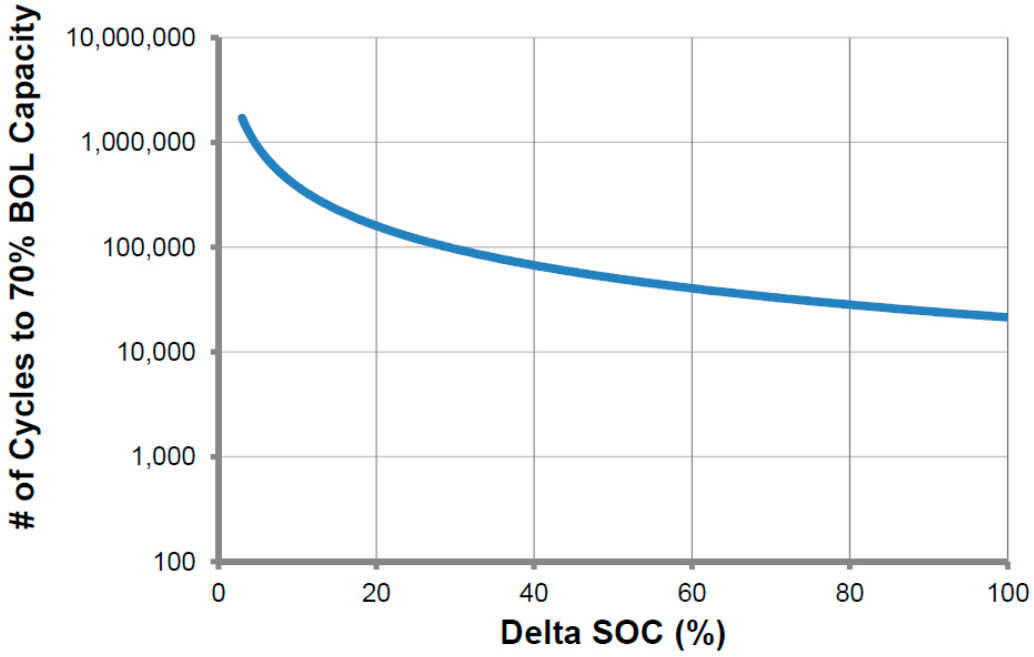
Balancing

Over time, the ALM 12V35 cells diverge in both capacity and SOC. All ALM 12V35 batteries perform cell voltage balancing at high SOC values based on cell voltage to maximize the available capacity of the battery. The balancing circuit's purpose is to drive all cells to the same voltage. Cell balancing continues on a per-cell basis as long as the cell voltage exceeds 3.385 volts.

ALM 12V35 batteries are shipped at 50% SOC. Fully charging the ALM 12V35 and holding the ALM 12V35 at float voltage for 4-24 hours prior to first use will ensure optimal balance and maximize the first discharge delivered capacity.

Cycle Life

Cycle life is dependent upon charge and discharge rates, operating temperature, calendar time and state of charge swing or delta SOC. Figure 13 projects cycle life expectations as a function of delta SOC where reducing delta SOC results in greatly enhanced cycle life.



Number of cycles is dependent upon average SOC, charge/discharge rates, temperature and calendar time. Actual results will depend on specific use cases. Contact NEC Energy Solutions for more details.

Figure 13 Cycle Life versus Delta SOC Behavior of Nanophosphate® Lithium-Ion Cell

After 6 years of continuous testing, original A123 Systems ANR26650*M1*A cells still retain 65% of their initial capacity after 20,000 full depth of discharge (100% DOD), +1C/-1C cycles at 23 °C. The ALM 12V35 batteries use the next generation ANR26650*M1*B. Through testing under the same conditions, cells of this model are demonstrating further improved cycle life behavior over their predecessors, as shown in Figure 14.

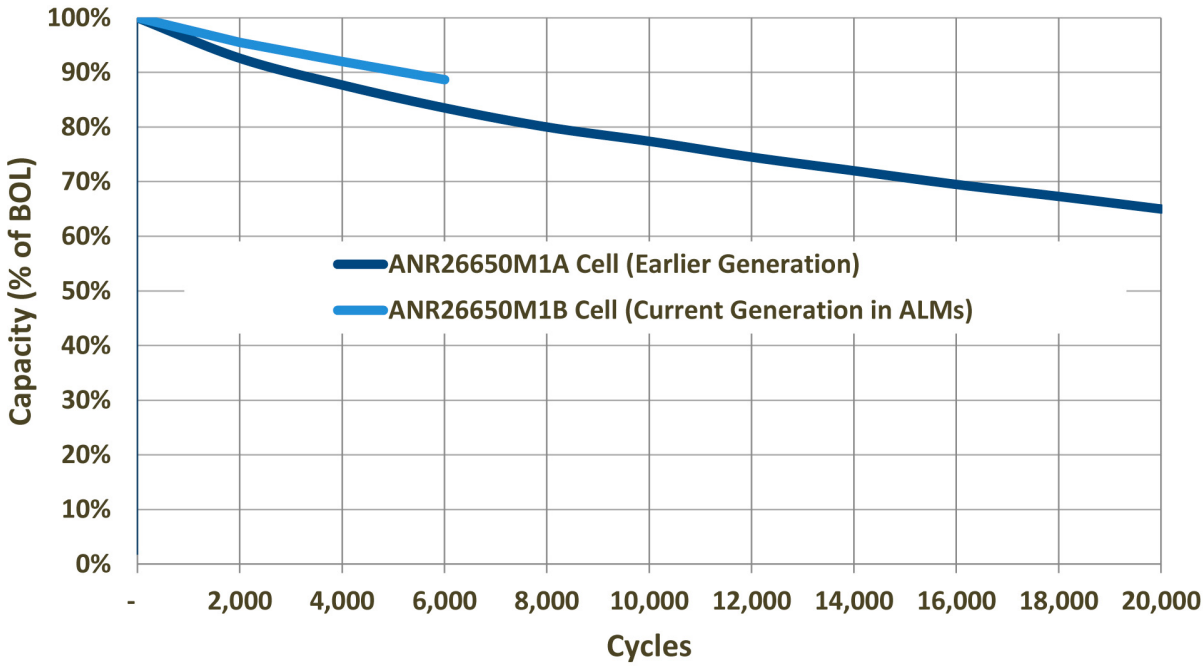


Figure 14 Cycle Life Test Results +1C/-1C, 23 °C, 100% DOD

NOTE

The number of cycles, as shown in Figure 13 and Figure 14, is dependent upon average SOC, charge/discharge rates, temperature and calendar time. Actual results will depend on specific use case. Contact NEC Energy Solutions for more detail.

NOTE

Overall system life is a function of Shelf Life (Time at temperature) and Cycle life (charge discharge rates and watt-hour throughput).

Shelf Life

ALM 12V35 batteries ship from the factory at approximately 50% State of Charge (SOC) and can remain functional for two years of shelf life where temperatures do not exceed 25 °C.

ALM 12V35 batteries being shipped by Air must comply with ICAO regulations, which requires that the batteries be at or below a 30% SOC. These batteries shipped by Air can remain functional for 16 months of shelf life where temperatures do not exceed 25 °C.

Storage temperatures above 25 °C accelerate the rate of self-discharge and reduce the shelf life.

At 10% SOC, the ALM 12V35 battery has about 5% of usable energy, on average, before entering into an Under Voltage Protection (UVP) state as described in Over Discharge Protection (Under Voltage Protection), on page 32. NEC Energy Solutions recommends applying a charge source whenever a battery is at 10% or lower SOC.

The ALM 12V35 battery will automatically discontinue a discharge operation when it reaches roughly 5% State of Charge (SOC), and will then disconnect its terminals. Due to the electrical drain within the battery management system; after the battery reaches the 5% SOC level at the Under Voltage Protection UVP state there is a limited time that the battery can remain without being charged. If the ALM 12V35 is discharged to the UVP 5% SOC level, it has approximately 34 days in this state, at 25 °C, before reaching its lowest power mode called the Under Voltage Lock-Out (UVLO) state. Once the battery reaches the UVLO state, it has approximately 26 days of shelf life before becoming permanently disabled.

For the ALM 12V35i HP CAN Bus and SMBus batteries, NEC Energy Solutions recommends disabling t communications before the battery enters into UVP state. If the battery communication port is kept active during UVP, the time to reach the UVLO state will shorten considerably due to the power draw from the battery communications circuits. In the UVP state, a battery has approximately 18 hours, at 25 °C, before reaching UVLO. Once the battery reaches the UVLO state, it has approximately 26 days before becoming permanently disabled.

While in UVLO, an ALM 12V35 battery can accept a small charge current through a precharge circuit to bring the battery to its proper operating range. Once the battery reaches the UVP state, it can accept a full rated charge current. NEC Energy Solutions recommends that the full rate charge remains until the battery is fully charged. Partial charges are acceptable, but they will limit the shelf life the battery can sustain in storage.

Durée de Conservation

Toutes les batteries ALM 12V35 sont expédiées de l'usine à environ 50 % d'état de charge (SOC) et restent fonctionnelles pendant deux ans, à condition que les températures ne dépassent pas 25 °C.

Les batteries ALM 12V35 expédiées par voie aérienne doivent être conformes aux règlements de l'OACI, qui exigent que ces batteries présentent un état de charge de 30 % maximum. Elles peuvent rester fonctionnelles pendant 16 mois, à condition que les températures ne dépassent pas 25 °C.

Les températures de stockage supérieures à 25 °C accélèrent le taux d'autodécharge et réduisent la durée de vie.

À un état de charge de 10 %, la batterie ALM 12V35 dispose d'environ 5 % d'énergie utilisable avant de passer en mode de protection contre les sous-tensions (UVP), tel que décrit dans la section Protection contre la décharge accélérée (protection contre les sous-tensions (UVP)), à la page 32. NEC Energy Solutions recommande d'utiliser une source de chargement dès qu'une batterie présente un état de charge de 10 % ou moins.

La batterie ALM 12V35 interrompra automatiquement une opération de décharge lorsqu'elle atteint un état de charge d'environ 5 %, puis elle déconnectera ses bornes. En raison du drainage électrique dans le système de gestion de la batterie, une fois que la batterie atteint un état de charge de 5 % en mode de protection contre les sous-tensions (UVP), elle peut rester déchargée durant une période limitée. Si la batterie ALM 12V35 est déchargée à 5 % en mode UVP, elle reste environ 34 jours dans cet état, à 25 °C, avant d'atteindre son mode

d'alimentation le plus bas, appelé le Verrouillage de sous-tension (UVLO). Une fois que la batterie est en mode UVLO, elle dispose d'environ 26 jours avant de subir un endommagement permanent.

Pour les batteries ALM 12V35i avec bus CAN HP et SMBus, NEC Energy Solutions recommande de désactiver les communications avant que la batterie ne passe en mode UVP. Si le port de communication de la batterie reste actif en mode UVP, la batterie passera beaucoup plus rapidement en mode UVLO, en raison de la consommation électrique des circuits de communication de la batterie. En mode UVP, une batterie dispose d'environ 18 heures, à 25 °C, avant de passer en mode UVLO. Une fois qu'elle passe en mode UVLO, elle dispose d'environ 26 jours avant de subir un endommagement permanent.

En mode UVLO, une batterie ALM 12V35 peut accepter un faible courant de charge à travers un circuit de précharge pour atteindre sa bonne plage de fonctionnement. Une fois qu'elle passe en mode UVP, elle peut accepter un courant de charge nominale maximum.
NEC Energy Solutions recommande de maintenir la charge maximale jusqu'à ce que la batterie soit complètement chargée. Les charges partielles sont acceptables, mais elles limiteront la durée de vie de la batterie lorsqu'elle est stockée.

Chapter 6

ALM® 12V35i Intelligent Battery Communications

Overview

The ALM 12V35i Intelligent Batteries provide two connections for industry standard CAN bus or SMBus communications with the internal microprocessor firmware. Signals for these protocols are included on the 9-pin D-sub connectors at the end of the two communication cables. One cable is considered incoming and the other outgoing. The connectors mate together (one male, one female) so that one battery's bus output cable can be connected to the next battery's bus input cable in any order.

This chapter includes the following topics:

ALM 12V35i Battery Communications Reference Documents

Table 18 shows the ALM 12V35i Intelligent Series Battery documents available from NEC Energy Solutions:

Table 18 ALM 12V35i Intelligent Series Battery Documents

Document Title	Document Part Number
ALM Intelligent (i-Series) Battery Control Area Network (CAN) Programmer's Reference Guide	MD405009-05EN
ALM Intelligent (i-Series) Battery SMBus Programmer's Reference Guide	MD405009-06EN
ALM Intelligent (i-Series) Battery Software User's Guide for CAN bus and SMBus	MD405009-07EN

ALM 12V35i Control Area Network (CAN) Interface

Introduction

CAN is a standardized, low-cost, multi-master, broadcast network that is well suited for smart battery applications. The ALM 12V35i battery CAN interface provides access to battery status and configuration information. Through the serial interface the end-user can monitor battery performance, be notified of alarm or warning conditions, and configure the CAN communications parameters and battery's behavior. It has error detection, fault containment and nondestructive arbitration built into the hardware layer. This makes for a robust network that can operate reliably in electrically noisy environments.

The ALM 12V35i network interface is compatible with CAN-to-USB adapters that provide galvanic isolation only. The Kvaser Leaf Light V2 has been evaluated by NEC Energy Solutions and is known to work. Other CAN-to-USB adapters that provide galvanic isolation may work, but compatibility cannot be guaranteed. In addition to the CAN-to-USB adapter, two CAN terminators must be used, as shown in Figure 15, on page 50, even if the system contains only one ALM 12V35i battery.

The ALM 12V35i CAN protocol is based on the CANopen application layer and communication profile as defined by 'CAN in Automation' (CiA) 301 version 4.2.0. This specification defines the CANopen application layer, which includes data types, the object dictionary and communication services. CAN interface specifications are available on the CiA web site at:

http://www.can-cia.org/

The ALM 12V35i application data transmitted over the CANopen protocol is derived from the Smart Battery Data Specification version 1.1. The Smart Battery commands, data type, formatting, and resolution are defined in the specification.

Several NEC Energy Solution specific commands have been added to the CANopen interface to customize the operation of the ALM 12V35i battery. Reference the *ALM Intelligent (i-Series) Battery CAN bus Programmer's Reference Guide* for details.

CAN Network Configuration

To establish CAN communications between 1 or more ALM 12V35i batteries mate the male and female DB-9 connectors and terminate the bus as shown in Figure 15. The CAN Bus interface allows up to 40 ALM 12V35i batteries to be daisy-chained into one link.

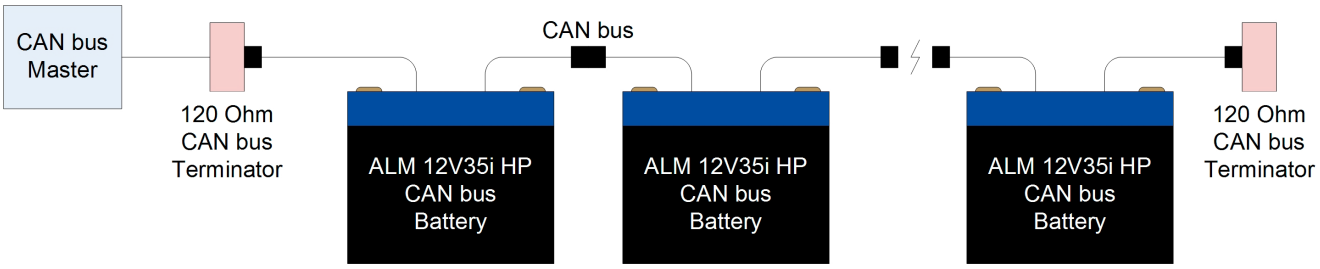


Figure 15 ALM 12V35i HP CAN bus Wiring

The length of the CAN network cable can vary depending on the application. Table 19 lists the maximum recommended cable length as a function of bit rate.

Table 19 CAN Bit Rate vs. Cable Length

CAN cable length	CAN bit rate
100 ft (30.5 m)	1 Mbit/s
200 ft (61 m)	500 kbit/s
300 ft (91.4 m)	250 kbit/s

CAN bus Settings

The default CAN bit rate is 125 kbit/s with the sample point set to 75% and a synchronization jump width of 2 bits. The CAN bus bit rate is user configurable and can be set to 1 Mbit/s, 500 kbit/s, 250 kbit/s and 125 kbit/s.

CAN bus Initialization and Configuration

The ALM 12V35i battery supports the CANopen network management layer (NMT) through which network control services are provided. The NMT master controls the state of the slave nodes on the CAN bus by issuing individual or broadcast commands. The ALM 12V35i (slave node) is in the pre-operational state upon wake from low-power mode and will require two consecutive NMT commands to enter Operational state (the first wakes up the battery and is not processed). NMT services and state control are defined in section 7.2.8 of the CiA-301 specification.

The ALM 12V35i supports Layer Setting Services (LSS), which allow the CAN master to detect nodes on the bus. Registered nodes can have their bit rate changed or unique Node-ID assigned.

CANopen Dictionary

The CANopen dictionary is a functionally organized data store used to define the logical interface to the ALM 12V35i battery. It acts as an interface between the battery application and the CANopen protocol by providing an interface to node configuration and process data objects. An example of CANopen Layers is shown in Figure 16.

Configuration objects describe network properties and devices whereas Process data objects are more application oriented and include elements like battery temperature, current and voltage.

The ALM 12V35i CANopen dictionary complies to the CiA 306 V1.3.0: CANopen electronic data sheet specification and can be accessed through the use of standard Service Data Objects (SDO). For more details about the CANopen dictionary, refer to the *ALM Intelligent (i-Series) Battery Can bus Programmer's Reference Guide*.

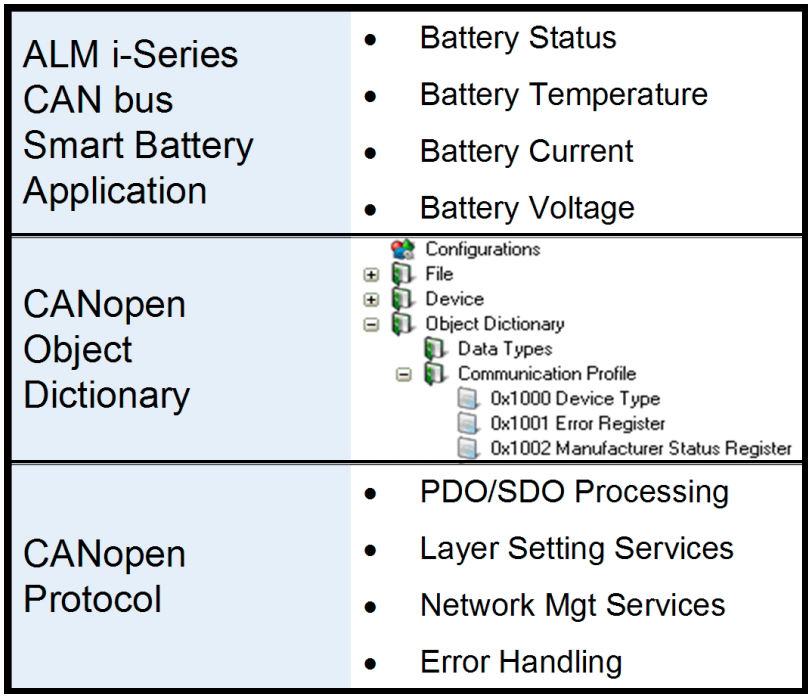


Figure 16 CANopen Layers

Smart Battery Data

The ALM 12V35i CAN bus interface follows the *Smart Battery Data Specification version 1.1* as defined by the SBS Implementers Forum. The document can be found on the SBS-IF web site at:

http://sbs-forum.org/

ALM 12V35i System Management Bus (SMBus) Interface

Introduction

The ALM 12V35i battery is equipped with a SMBus interface to enable remote monitoring and control functions. SMBus is an industry standard two-wire serial communication interface well suited for communicating with intelligent batteries. The ALM 12V35i is configured as a low-power SMBus slave, operating up to 100 kbit/s with optional packet error checking. For a single battery, a low-power SMBus master device may be used. When using more than one ALM12V35i SMBus slave in series on the communication bus, a high-power master device must be used. It utilizes SMBus read/write commands to communicate Smart Battery Data to the host (bus master).

The ALM 12V35i SMBus interface follows the *Smart Battery Data Specification, version 1.1* as defined by the SBS Implementers Forum. The document can be found on the SBS-IF web site at:

http://sbs-forum.org/

Figure 17 illustrates the relationship between the ALM 12V35i battery application and Smart Battery Data Specification and the SMBus interface.

ALM i-Series SMBus Smart Battery Application	• Battery Status • Battery Temperature • Battery Current • Battery Voltage
Smart Battery Data	• Relative State of Charge • Remaining Capacity • Runtime to Empty • Design Voltage
SMBus Protocol	• Read/Write Byte • Packet Error Checking • Device Identification • Addressing

Figure 17 ALM 12V35i SMBus Interface

SMBus Network Configuration

To establish SMBus communications between the ALM 12V35i batteries, mate the male and female connectors as shown in Figure 18. The SMBus interface allows up to 8 daisy-chained ALM 12V35i batteries.

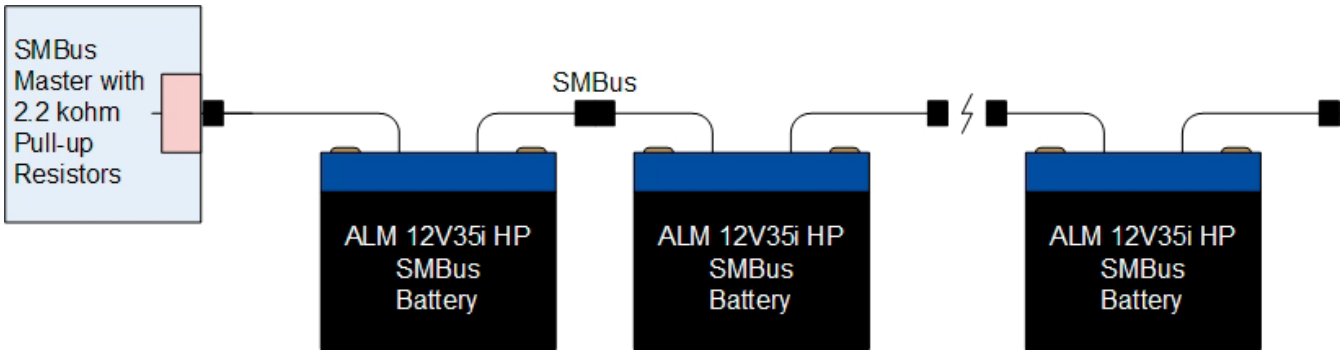


Figure 18 ALM 12V35i SMBus Wiring

The SMBus specification has a separate set of electrical specifications for devices that do not reside on the PC motherboard. The 'high power' SMBus interface on the ALM 12V35i can support cable lengths up to 3 meters. The SMBus master should pull-up the clock and data lines with 2.2 kohm resistors.

SMBus Protocol Configuration

To communicate with the ALM 12V35i over the SMBus interface the bus master should utilize the default address of 0x0B hex (128 decimal) at a bit rate of approximately 100 kbit/s.

Packet error checking is supported by the ALM 12V35i SMBus protocol. Any message received with the packet error code (PEC) appended will be responded to in kind. See the SMBus specification 2.0 section 5.4 for details on PEC.

The Address Resolution Protocol (ARP) is not supported; however a vendor specific command code is available for setting the device address. The *ALM Intelligent (i-Series) Battery SMBus Programmer's Reference Guide* describes the device address command code and message format.

The SMBus host notify protocol is not supported by the ALM 12V35i battery.

Smart Battery Data Specification

The ALM 12V35i presents data as defined by the *Smart Battery Data (SBD) specification v1.1*, on the SMBus. There are several vendor specific command codes appended to the SMBus interface to facilitate operations such; reading out the battery performance data, setting warning levels or changing the device address. The *ALM Intelligent (i-Series) Battery SMBus Programmer's Reference Guide* contains the command codes and message format details required to communicate with the battery.

Battery Performance Data Archive for CAN bus and SMBus

The ALM12V35i battery stores several types of environmental, performance and event data in an internal nonvolatile memory (NVM). A record of Battery voltages and temperature levels is written to memory every ten seconds. This record of the battery's operating conditions can be read out for performance analysis and warranty candidate evaluation. A log entry is created and stored in NVM when an event is detected by the battery. Refer to Appendix A, ALM® 12V35 Operational Protection Alarms and Settings on page 56, for a list of firmware recorded events and customer-configurable event threshold settings.

Several custom message IDs have been added to the CANopen dictionary and the SMBus Message Manifest to enable the readout of the event logs and profiler data from the battery. For details refer to the *ALM Intelligent (i-Series) Battery Can bus Programmer's Reference Guide,* the *ALM Intelligent (i-Series) Battery SMBus Programmer's Reference Guide,* and the *ALM Intelligent (i-Series) Battery Software User's Guide for CAN bus and SMBus*.

Troubleshooting

Overview

The ALM 12V35 batteries are extremely reliable batteries that provides greater useful life than comparable 12V35 lead-acid batteries. Despite the high reliability of the ALM 12V35 batteries, you may encounter situations where the battery does not operate as expected. This chapter details potential issues with integrating the ALM 12V35 batteries and the appropriate troubleshooting procedures.

Table 20 ALM 12V35 Troubleshooting and Solutions

Problem	Possible Cause(s)	Solution(s)
The battery does not deliver the expected Ah (capacity).	1. The battery is out-of-balance. 2. The battery has reached the end of its useful service life. 3. The battery overheated due to ambient temperature or C-Rate.	1. Apply a float charge for 48 hours to balance the battery cells. 2. Replace the battery. 3. Reduce the ambient temperature or C-Rate.
Charge current suddenly goes to zero while connected to a source.	1. The battery overheated, enabling over-temperature protection. 2. The battery is out-of-balance. 3. Charge current is too high, exceeding OCP protection. [a]	1. Allow the battery to cool. 2. Apply a float charge for 48 hours to balance the battery cells. For more details on charging battery, batteries, or strings, refer to Charging Single Batteries on page 36 and Charging Multiple Batteries on page 39. 3. Reduce charge current.
Voltage drops abruptly while in use after appearing constant.	1. The battery is fully discharged. 2. OCP has engaged	1. Perform a charge cycle. 2. Reduce the load.
Low or zero volts across the terminal	1. The battery is in UVP or UVLO. 2. The battery is in OTP.	1. Perform a charge cycle. 2. Allow the battery to cool.

a. High-speed OCP occurs in10 µs so it will not be visible on a digital volt meter.

Appendix A

ALM® 12V35 Operational Protection Alarms and Settings

Table 21 lists the ALM 12V35i Operational Protection matrix covering warnings, alarms and hardware circuitry for voltage and temperature.

The values in bold-red text in Table 21 on page 57 are user-configurable settings for the ALM 12V35i Intelligent Batteries. Refer to the *ALM Intelligent (i-Series) Battery Software User's Guide for CAN bus and SMBus* and the relevant ALM Intelligent (i-Series) Programmer's Reference Guide for details on alarm messages and how to set these values.

Table 21 uses the following abbreviations:

- **FETs**: Field-Effect Transistors
- **FW**: Firmware
- **HW**: Hardware
- **OTP**: Over-Temperature Protection
- **OVP**: Over-Voltage Protection
- **UVP**: Under-Voltage Protection
- **UVLO**: Under-Voltage Lock-Out
- **UTP**: Under-Temperature Protection

Table 21 ALM 12V35 Operational Protection Settings

Parameter	Set Value ALM 12V35s	Set Value ALM 12V35i HP	Clear Value ALM 12V35s	Clear Value ALM 12V35i HP	Applies to
OVP warning FW	N/A	**>3.80 V** [a]	N/A	.15 V less than set	Any cell
OVP alarm FW	N/A	**3.95 V**	N/A	3.7 V	Any cell
OVP HW	>4.1 V	>4.1 V	<4.1 V	<4.1 V	Any cell
OVP-2 HW	4.25 V	4.25 V	Never [b]	Never [b]	Any cell
UVP warning FW	N/A [c]	**<2.80 V**	N/A	>2.90 V	Any cell
UVP alarm FW	N/A	<2.20 V	N/A	>2.70 V	Any cell
UVP HW	2.00 V	2.00 V	>2.50 V	>2.50 V	Any cell
Battery lockout HW	<.7 V	<.7 V	Never [b]	Never [b]	Any cell
UVLO mode HW	5.1 V (No charger)	5.1 V (No charger)	5.5 V (With charger)	5.5 V (With charger)	Battery
OTP cell warning FW	N/A	**>63 °C**	N/A	<53 °C	Any cell
OTP cell alarm FW	N/A	>68 °C	N/A	<63 °C	Any cell
OTP cell HW	68 °C	68 °C	63 °C	63 °C	Any cell
UTP warning FW	N/A	<-10 °C	N/A	>-5 °C	Cell Charging
OTP FET warning FW	N/A	**100 °C**	N/A	<95 °C	Cell Charging
OTP FET alarm FW	N/A	110 °C	N/A	<104 °C	FETs
OTP FET HW	110 °C	110 °C	75 °C	104 °C	FETs

a. The values in bold-red text are user-configurable settings.

b. Internal circuitry does not allow this event to clear.

c. N/A = Not Applicable. The ALM 12V35s does not support firmware.

Appendix B

Acronyms and Terminology

The following table lists and describes acronyms and terms used in this guide.

Term/Acronym	Description
Ah	Amp-Hour is a unit of measure of charge that can be stored or delivered to/from a battery.
Battery	One or more cells that are electrically connected together by permanent means, including case, terminals and markings.
BMS	Battery Management System – The Battery Management System refers to the collection of electronics responsible for monitoring and controlling an ESS. The ALM 12V35 does not require an external BMS (See Battery Configuration Options on page 17).
BOL	Beginning of Life – at the time the product was first assembled at the factory.
CC	Constant Current – A method to charge or discharge a battery in which the current is held constant independent of the battery's terminal voltage.
CE	Conformité Européenne, meaning "European Conformity"- Tests and Certifies safe and compliant product operation in Europe.
Cell	The individual A123 Systems ANR26650*M1B* cell is the basis for the ALM 12V35 battery.
CFET	Charge control FET
C-Rate	An electrical current value corresponding to that which will fully charge or discharge a battery in one hour.
CV	Constant Voltage – A method to charge a battery in which the terminal voltage is held constant, and the current is determined by the power path impedance or some active current limiting.
$CV^2/2$	Formula for Energy stored in capacitance
DFET	Discharge control FET (See FET.)
DOD	Depth of Discharge
EMC	ElectroMagnetic Compatibility
EOD	End of Discharge

Term/Acronym	Description
ESS	Energy Storage System
FCC	Federal Communications Commission. RF Emissions governing body in the United States.
FET	Field-Effect Transistor, used for switching high current levels.
FW	Firmware
HW	Hardware
kbit/s	kilobit per second
$LI^2/2$	Formula for Energy stored in inductance
LVBD	Low Voltage Battery Disconnect
LVCO	Low Voltage Cut-off
LVLD	Low Voltage Load Disconnect
Mbit/s	Megabit per second
OCP	Over Current Protection
OTP	Over-Temperature Protection
OVP	Over-Voltage Protection
OEM	Original Equipment Manufacturer – in reference to this document, the maker of the equipment into which an ALM battery is installed and used.
Nominal Energy	The energy value of a cell or battery determined under specified conditions and declared by the manufacturer. The nominal energy is calculated by multiplying nominal voltage by rated capacity expressed in ampere-hours. Also known as Watt-hour rating.
Nominal Voltage	The approximate value of the voltage used to designate or identify a cell or battery
NVM	Nonvolatile Memory is a general term for all forms of solid state (no moving parts) memory that has the capability to hold saved data even when its power is turned off. Unlike volatile memory, it does not require periodic refreshing of its memory contents.
Room Temperature	The range between 20 and 23 °C (68 and 73 °F), with an average of 21.5 °C (70.7 °F).
SOC	State of Charge
Touch Temperature	The external surface temperature of various battery components
UL	Underwriter Laboratories - Tests and Certifies safe and compliant product operation in North America & internationally
UVP	Under Voltage Protection

Term/Acronym	Description
UVLO	Under Voltage Lock-Out
UTP	Under-Temperature Protection
Wh	Watt-Hour rating (see also Nominal Energy rating)

Related Documents and Resources

- Link to International Civil Aviation Organization (ICAO) Technical Instructions: http://www.icao.int/safety/DangerousGoods/Pages/default.aspx
- Link to International Air Transport Association (IATA) Dangerous Goods Regulations: http://www.iata.org/whatwedo/cargo/dgr/Pages/lithium-batteries.aspx
- Link to International Maritime Dangerous Goods (IMDG) Code: http://www.imo.org/Publications/IMDGCode/Pages/Default.aspx
- Link to Lithium Battery Regulations on United Parcel Service web site: http://www.ups.com/media/news/en/intl_lithium_battery_regulations.pdf
- Link to the CANbus interface specifications on the CiA web site: http://www.can-cia.org/index.php?id=specifications&no_cache=1/s
- Link to Smart Battery Systems Implementers Forum and SMBus specifications: http://sbs-forum.org//
- Link to the SMBus interface specifications on the SMBus.org web site: http://smbus.org/
- UN Recommendations on the Transport of Dangerous Goods - Manual of Test Criteria
- UN Recommendations on the Transport of Dangerous Goods Model Regulations
- U.S. Department of Transportation (DOT), Office of Pipeline and Hazardous Materials Safety Administration (PHMSA): Title 49 CFR Sections 100-185 of the U.S. Hazardous Materials Regulations (HMR)

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NEC ENERGY SOLUTIONS

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